Arnold Schwarzenegger
Governor

MAINTAIN, ENHANCE AND IMPROVE RELIABILITY OF CALIFORNIA'S ELECTRIC SYSTEM UNDER RESTRUCTURING

APPENDIX - XIII

Agent-Based Simulation of an Automatic Mitigation Procedure

PIER FINAL PROJECT REPORT

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California Energy Commission
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Prepared By:

Lawrence Berkeley National Laboratory

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Agent-Based Simulation of an Automatic Mitigation Procedure

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PRODUCT DESCRIPTION

This report describes experiments using computer-based agents to simulate the impact of the California Independent System Operator's proposed Automatic Mitigation Procedure (AMP) on market behavior. These computer agents play the role of market participants seeking to maximize their profits as they formulate bids under a number of scenarios over a simple, two-node market at various levels of demand and transfer capability and with and without the AMP in force. The study demonstrates that agent-based simulation is a useful tool for analyzing existing and proposed design features of electricity markets.

Results & Findings

The simulations show that the AMP is effective in reducing market clearing prices under situations when they would otherwise reach the price cap and that congestion rents can be fleeting when suppliers are able to equalize prices across zones through strategic bidding. The report documents many insights into bidding strategies, market behavioral measures, and the process of analyzing market performance. However, the long-term effects of the AMP on investment incentives and its potential to help coordinate out-of-market activities lie beyond the capabilities of this type of simulation.

Challenges & Objectives

Although this project was developed primarily for people who are interested in applying agent-based simulation to design issues in electricity markets, it is a groundbreaking exercise whose lessons are worth sharing more broadly. The report will also be of interest to any person who studies or participates in the electricity markets in California. Price mitigation is highly relevant to the mitigation of local market power. The focus of the experiments was limited to the very short term, but the larger subject of market power mitigation is integral to long-term questions of planning and the balance between generation and transmission solutions to enhanced power delivery. Further work is needed to understand both the real-life consequences of local market power mitigation and its potential role in capacity planning.

California's experience shows that the unintended consequences of decisions on market rules can be very costly and that simulating the consequences of decisions on market rules before implementing them can have enormous benefits. Agent-based market simulations can help guide the transformation of the energy market by improving understanding of electricity market behavior.

Applications, Values & Use

Because agent-based simulation strives to mimic and thus represent the real world, its successful application depends on empirical results from independent market analyses and from economic experiments with human subjects on real world market behavior as well as on expert input to focus developments and analysis. Future studies using the technology will benefit from more realistic market data and the study of longer time frames. The approach can also be extended to include additional products like ancillary services, to model more complete markets, and to handle multiple settlements of products where behaviors depend on sequences of decisions under uncertainty.

EPRI Perspective

EPRI has pioneered the development and application of agent-based simulation for the study of decision-making associated with electricity markets. While similar experiments using actual human beings are not new—a recent Nobel Prize in Economics went to pioneers in this "Experimental Economics" approach— EPRI builds on this experience by replacing people with computer programs that make the same decisions. The goal is to develop agents that can mimic human decision-making processes in order to better predict actual market behavior.

Approach

This report documents the use of agent-based simulation as a tool for studying the California ISO's Automatic Mitigation Procedure. The project team devised market clearing mechanisms to implement and agent decision-making procedures to form bids in this market environment. The team ran simulations over numerous scenarios of demand and line capacity for a two-node network using a stylized model of the California system. They designed the scenarios to elicit competitive and non-competitive market behavior both with and without network congestion. Throughout the project, EPRI maintained close coordination with its contractors and the California ISO.

Keywords

Electricity markets
Agent-based simulation
Economics
Market power
Competition

ABSTRACT

This report describes experiments using computer-based agents to simulate the impact of the California ISO's proposed Automatic Mitigation Procedure on market behavior. The agents play the role of market participants by formulating bids to maximize their profits. They exercise their skills under a number of scenarios with and without AMP being present and for various levels of demand and transfer capability over a simple, two-node market. The results of these experiments indicate that AMP is effective in reducing market clearing prices under situations when they would otherwise reach the price cap. In congested networks, congestion rents can be fleeting when suppliers are able to equalize prices across zones through strategic bidding. The analysis of significant issues such as the long-term effect of the AMP on investment incentives or its potential to help coordinate out-of-market activities lies beyond the capabilities of this type of simulation.

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EXECUTIVE SUMMARY

This report describes experiments using computer-based agents to simulate the impact of the California ISO's proposed Automatic Mitigation Procedure on market behavior. These agents play the role of market participants by formulating bids to maximize their profits. They exercise their skills under a number of scenarios with and without AMP being present and for various levels of demand and transfer capability over a simple, two-node market.

In Paragraph 64 of their June 17, 2002 Ruling to the California ISO [7], FERC states, "a fundamental purpose of AMP is to limit the exercise of market power, not to suppress prices during scarcity conditions." This, the first sentence of their ruling on AMP, frames the design of the following experiments and analysis that constitute this study. We attempt to simulate market behavior under tight system conditions to see what limits it places on prices and how these limits allow prices to rise under conditions of scarcity.

Simulation Technique

Our goal for this report was to document the use of agent-based simulation as a tool for studying the California ISO's Automatic Mitigation Procedure (AMP). We devised market clearing mechanisms and implemented agent decision-making procedures to form bids in this market environment. The simulations were run over numerous scenarios of demand and line capacity for a two-node network, stylized on the California system. The scenarios were designed to elicit competitive and non-competitive market behavior both with and without network congestion.

Prior to conducting these experiments, two essential exercises were accomplished. First, as the technology was developing, important comparisons were made with theoretical results and documented economic experiments with human subjects in order to ensure reasonable behavior of the agent-based simulations. Second, the design of the Automatic Mitigation Procedure was reviewed and analyzed by industry and academic experts in an effort to focus and direct the experimental phase of the projects. Without these two essential exercises, the experiments would have been unconnected, without relation to the real world.

Primary Results

The results of our experiments indicate that AMP is effective in reducing market clearing prices under situations when they would otherwise reach the price cap. Specific to congested networks, the results also reveal that congestion rents can be fleeting when suppliers are able to equalize prices across zones through strategic bidding. Pitfalls like the long-term effect on investment incentives or the potential to help coordinate out-of-market activities are of concern, but their analysis lies beyond the capabilities of this type of simulation. Further, we have discovered and documented many insights into bidding strategies, market behavioral measures, and the process of analyzing market performance.

Conclusions

The obvious conclusion of this study is that AMP has the effect of a price cap and is effective in the short term at lowering market-clearing prices when supply conditions are tight or line capacity is reduced. This reduction does not seem to differentiate between scarcity and market power. In the long-term, the lack of differentiation between scarcity and market power could lead to a capacity shortages if the price reductions are too severe, because of the reduced incentive for new investment.

The presence of pivotal suppliers and the reference prices of the highest cost units are the determining factors for non-competitive prices. There was a significant reduction in the number of non-competitive scenarios attributable to AMP, but more-realistic simulations, coupled with load duration statistics are needed to judge the true magnitude of this impact.

Beyond the obvious conclusions lay several more subtle insights, for instance:

- Even simulation agents, acting without explicit collusion or super-sophisticated analytical tools, can (besides capturing congestion rents) manage to avoid triggering the impact screen and therefore drive prices considerably above the levels of the conduct screen.
- As structured in our scenarios, AMP is effective in promoting more competition in the short term than would be the case without it. This is because it has the same effect as a price cap, and thus suffers the same liability of reducing long-term incentives for investment. In the long term, AMP may be responsible for inadequate capacity if not managed very carefully. A more realistic model and correlation to load duration statistics is needed to better assess how much more competition results from AMP.
- Suppliers in this simple two-node example are quite able to extract congestion rents. This is especially true when supplies are so tight that there are pivotal suppliers in both regions.
- Bidding behavior very much depends on AMP. AMP does not simply reduce bids in particular circumstances, it changes the incentives to exercise market power and hence indirectly changes bids in situations where no bids are mitigated directly.
- A careful design of AMP would account for its potential use as a facilitating mechanism. That is, certain market participants could trigger AMP or threaten to trigger AMP as a means of extracting benefits they would not otherwise obtain.

One of the main benefits of simulation derives from improving our understanding of how a particular AMP implementation reduces incentives to exercise market power. This was evident in the figures that showed the regions of pivotal players and non-competitive behavior. Detailed inspection of agent bidding practices showed that AMP increases the risks of bidding high, further confounds the decision-making process, and reduces the level of the maximum achievable price. All of these factors combine to make the market we have modeled more competitive under AMP.

The FERC statement that AMP reduces market power while not suppressing prices under scarcity conditions is supported by the evidence that AMP introduces a level of uncertainty that manifests a large transition region between two phases of market behavior: a competitive phase and a non-competitive phase. In severe conditions of scarcity, the market behavior approaches that of a monopoly that is restricted by AMP. This supports FERC's statement that prices can raise under scarcity conditions. The evidence also shows that oligopoly rents are substantially reduced, on average, while scarcity rents are little affected.

We expect further studies of this type in the coming years, and that through this experience, our community of interest will learn better how to utilize this technology and that the technology will be further driven to new heights of achievement and application. The two areas we have mentioned that could provide extended benefits are more realistic market data and the study of longer time frames. Other extensions useful are to handle additional products like ancillary services to model more-complete markets and to handle multiple settlements of products to model behaviors that depend on sequences of decisions under uncertainty.

The work described here contributes to better understanding of electricity market behavior in the abstract and potentially in real-life. Simulating decisions, whether how to bid or how to change market rules, before implementing them can have enormous benefits. As all of us have learned the hard way, the unintended the consequences of such decisions can be very costly. Our hope is that market simulation will be one of many tools that will bring stability and more secure benefits to all those who are participating in the transformation of electricity markets.

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1
INTRODUCTION

The Automatic Mitigation Procedure (AMP) of the California ISO is a methodology for altering certain specific supplier bids, after they have been submitted, by reducing their offer prices. Once the ISO has determined that bids should be mitigated, they then clear the market using the resulting market equilibrium to settle accounts.

Goals of AMP

In Paragraph 64 of their June 17, 2002 Ruling to the California ISO [7], FERC states, "a fundamental purpose of AMP is to limit the exercise of market power, not to suppress prices during scarcity conditions." This, the first sentence of their ruling on AMP, frames the design of the following experiments and analysis that constitute this study. We attempt to simulate market behavior under tight system conditions to see what limits it places on prices and how these limits allow prices to rise under conditions of scarcity.

The CA-ISO cites two examples, in their May 1, 2002 filing [6], of the types of bidding behavior that AMP is attempting to dissuade:

- Bids into the ISO markets that vary with unit output in a way that is unrelated to the known performance characteristics of the unit (also known as "hockey stick" bidding).

- Bids into the ISO markets that vary over time in a manner that appears unrelated to change in the unit's performance or to changes in the supply environment that would induce additional risk or other adverse shifts in the cost basis.

The first citation refers to the practice of exploiting supply shortages by bidding one or more high-cost units at or near the price cap. The second citation refers to bidding practices that vary according to the environmental circumstances of the market that are not related necessarily to a suppliers own operations, but to events affecting other aspects of the power system like demand levels and network characteristics.

Challenges in Simulating AMP

There are several serious challenges posed by attempting to simulate and analyze AMP. First is the inherent need to start with an abstract, but relevant, market model. Another challenge is devising a complement of scenarios that can, through observations of market behavior, illuminate key issues. Given our current, rudimentary starting point, identifying significant issues and behaviors is very challenging, and we have benefited from the experience of industry and academic experts' advice to accomplish this.

Finally, it has been quite a challenge to devise a reasonable and robust bidding strategy for our agents—one that performs well in a wide variety of circumstances. This report is not meant to fully document the agent strategies, but we do focus in on particular aspects where we believe it will help the reader to better understand the setup and especially the results.

In their ruling to the CA-ISO on AMP (see Appendix), FERC ordered that AMP be applied to the Real Time Market for electric power during the predispatch process occurring 45-minutes prior to the operating hour. FERC also instructed the ISO to utilize three screening processes to govern the activation of bid mitigation. They are called the conduct screen, impact screen, and price screen. The foundation of the screening process is so-called reference prices, to be determined by an independent entity for each generation unit. We assumed a simple method for determining reference prices, which is presented later. To explain these bid screens, we quote the ruling (see paragraph 67).

A. For the conduct screen, the threshold will be whether the individual bid would result in a 200 percent or a $100/MWh increase, whichever is less, above the reference price established for the unit;

B. For the impact screen, the threshold will be whether the aggregated bids that fail the price screen would result in a 200 percent or a $50/MWh increase, whichever is less, in the market clearing price;

C. For the price screen, if the market clearing price for all zones is $91.87/MWh or below, AMP will not be applied.

FERC ordered that reference prices for each unit apply to all hours of the day, exemptions apply for small portfolios once the full network model is in effect, and all bids below 25 $/MWh should be exempt from mitigation.

Methodology

The methodology that follows, for studying particular aspects of market design, is still in its infancy. It draws its inspiration from the area of Experimental Economics [1,2,3], wherein a number of enthusiastic researchers have found ways to prove experimentally that the real practice of economics differs from what theory assumes or predicts to be true. Thus is the theory augmented or revised.

Our version of experiments does not rely directly on real economic practice, nor does it rely completely on theory. It is an attempt to write computer programs for deciding how to bid into electricity markets in ways similar to those found by the experimental economists, who typically use real people. We have conducted a benchmarking study [4] in which we compare market behavior resulting from these two types of decision-makers, and we find that for the examples of markets tested, they behaved qualitatively the same in both cases. Similar findings were made in a larger, more-general effort conducted by the Santa Fe Institute [5].

This study is part of a larger research effort to promote the use of market simulation as a tool to test market design concepts and practices. It is one of two initial efforts to examine the benefits of this approach. The other study is of Available Capacity Markets in the California ISO designs [8]. Both studies have been performed with somewhat artificial data, and we recognize the limitations of this approach. Despite the simple nature of the examples, we feel that the insights they reveal are useful and interesting, acting to highlight the practicality and usefulness of simulating market designs in a laboratory setting.

Prior to conducting our experiments, two essential exercises were run. First, as the technology was developing, important comparisons were made with theoretical results and documented economic experiments with human subjects in order to ensure reasonable behavior of the agent-based simulations. Second, the design of the Automatic Mitigation Procedure was reviewed and analyzed by industry and academic experts in an effort to focus and direct the experimental phase of the projects. Without these two essential exercises, the experiments would have been unconnected, without relation to the real world.

2
EXPERIMENTAL SETUP

This chapter describes the environment, the institutions, and the agent behavior that were used in our experiments to test the Automatic Mitigation Procedure ruled by FERC.

Environment

Our description of the economic environment for our experiments is divided into three parts. The first part is what we call the *market model*. For our purposes, it is essentially the contents of a document that is used by the simulator to describe the market. Second are the *scenarios*, which have as independent parameters the demand and the amount of inter-nodal transmission capability. Third is *information availability*, which describes what the agents know when they make bid decisions.

Market Model

We utilize a stylized model of the California market, having two nodes (North and South) and eight suppliers (three in the north and five in the south). Please refer to the Data Tables Appendix for details of the ownership and cost structure of the suppliers. The demand side is always bid at a fixed quantity, and is present at both nodes.

All events in this experiment are assumed to take place over a short time period of one hour or less. The exact amount of time involved is important insofar as to support the validity of the assumption that system conditions, and thus market conditions, do not change substantially over this period.

Scenarios

We expect that the issues in the analysis of AMP will center on the question, "What is the difference between scarcity and local market power?" For instance, Paragraph 75 of the FERC order states "we believe that the AMP mechanism we approve in this order provides important protection and can properly differentiate between the exercise of such market power and true scarcity prices when demand is high."

Scarcity can be viewed as a legitimate physical reality in markets, and it is believed that prices should reflect scarcity in such a way as to encourage the entry of new supply or the exit of sensitive demand. To highlight this issue, we analyze the market under scenarios of varying loads and levels of transfer capability between the two nodes, which are designed to traverse the realms of competition, market power, and scarcity.

The base case system conditions are that the total supply is 21,050 MW and the total demand is 21,000 MW. With a transfer capability between the two nodes of the network of 2,000 MW there is no congestion, and the two trading regions are unified. In all of the scenarios, 100% of each supplier's capacity is uncommitted going into the market. This greatly strengthens the suppliers' incentives to exercise market power.

We vary the level of demand in six steps of 1,000 MW from 21,000 MW down to 15,000 MW, and we vary the transfer capability in six steps of 300 MW from 2,000 MW down to 200 MW. Reducing the demand moves the market environment from one of tight supply to relatively ample supply. Reducing the transfer capability creates local markets and somewhat halves the number of competitors in each.

The following tables contain the explicit values of demand and transfer capability.

Table 2-1
Demand Scenarios

Scenario	**0**	**1**	**2**	**3**	**4**	**5**	**6**
North Demand (MW)	6,800	6,476	6,152	5,829	5,505	5,181	4,857
South Demand (MW)	14,200	13,524	12,848	12,171	11,495	10,819	10,143
Total Demand	21,000	20,000	19,000	18,000	17,000	16,000	15,000

Table 2-2
Transfer Capability Scenarios

Scenario	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Transfer Capability (MW)	2,000	1,700	1,400	1,100	800	500	200

Note that we have numbered our scenarios from zero for the base case, and that we will run all combinations of demand and transfer scenarios for a total of 49 scenarios.

Table 2-3 lists the number of pivotal players for each scenario at both the North and South nodes. A description of the calculation for these values is contained in Appendix B, Related Calculations.

Table 2-3
Number of Pivotal Players for each Scenario and Node

Zone	Xfer Cap	Demand 21,000	20,000	19,000	18,000	17,000	16,000	15,000
North	2000	3	3	2	0	0	0	0
North	1700	3	3	2	0	0	0	0
North	1400	3	3	2	1	0	0	0
North	1100	3	3	2	2	1	0	0
North	800	3	3	3	2	2	1	0
North	500	3	3	3	3	2	2	1
North	200	3	3	3	3	3	2	2
South	2000	5	5	3	2	0	0	0
South	1700	5	5	3	2	0	0	0
South	1400	5	5	3	2	0	0	0
South	1100	5	5	3	2	2	0	0
South	800	5	5	3	3	2	0	0
South	500	5	5	4	3	2	2	0
South	200	5	5	5	3	2	2	0

When a supplier is pivotal, it can control the market-clearing price simply by bidding all of its capacity at the same desired price. However, doing so is not always the best way to increase profits. The level of quantity that is accepted by the market complicates the decision.

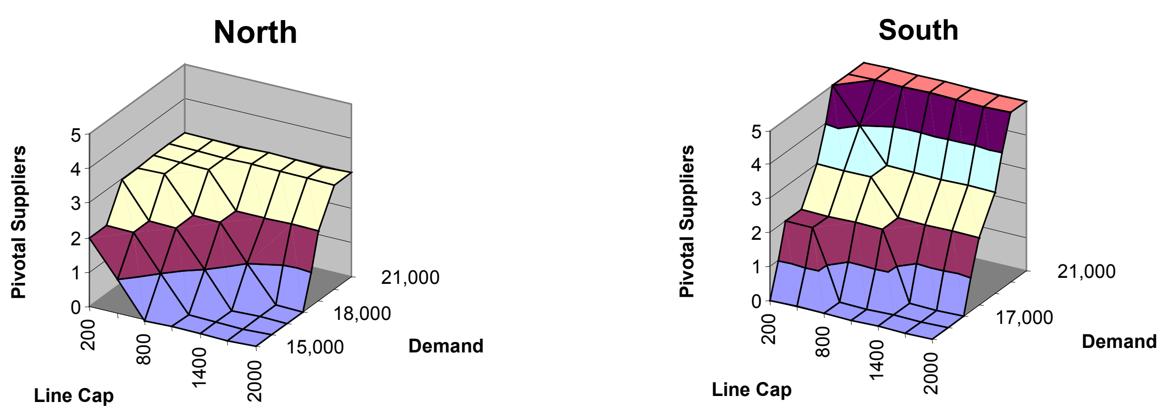

Figure 2-1
Number of Pivotal Suppliers in Each Scenario at Each Network Node

Figure 2-1 displays two surface charts of the number of pivotal suppliers in each scenario. We will revisit this concept often, but would like the reader to take note at this point of the general shape of each surface, and the regions where there do and do not exist pivotal players. The presence and number of pivotal suppliers is a key aspect of market behavior.

Information Availability

Available information affects the kind of decision problem that the suppliers must work with, and we have supplied the agents with three levels of information, Basic, Aggregated, and Network, which they utilize as needed. *Basic* information is the knowledge of their own costs and of public market information like the nodal market clearing prices and their own acceptance schedules. *Aggregated* information is the total supply and demand. This is used to determine whether they are pivotal when there is no congestion. *Network* information is the total supply and demand at each node of the network, the network topology, and the Power Transfer Distribution Factors (PTDFs). This is used to determine whether they are pivotal when the network is congested. Related to AMP, suppliers know its rules and how it is applied. So, for instance they know their individual reference and conduct prices, and the price screen at $91.87.

Institutions

Our experiments involve a single economic institution, a Real-Time market for electric power.[1] In this section, we describe the market in terms of how bids are formed and submitted, how the market is cleared, and how settlements are computed.

Bidding

Market participants bid fixed quantities of power at varying prices. The two demand players always bid their willingness-to-pay, which is set at 250 $/MWh. This is how we model inelastic demand. The supply bidders are free to choose the price at which they offer each block, but the maximum willingness to pay on the demand side effectively acts as a bid cap on suppliers. Suppliers must also bid 100% of their capacity into the market at or below this bid cap.

Market Clearing

Market clearing is always done in terms of meeting supply and demand so as to maximize the social welfare, subject to transmission limits. The problem formulation is a linear program. When the market clears on horizontal portions of the supply and demand curves, the quantity is cleared to satisfy the maximum demand possible.

The rest of this section documents our treatment of AMP, which is integral to market clearing. It begins with precise definitions of the three screening processes, and then describes the actions taken upon the determination that mitigation is warranted. One of the important aspects of our interpretation of AMP is that all market participants (both in and out of state) are treated as a single class of customers, where if any single participant triggers mitigation all of the participants will be subject to having their bids mitigated.

---

[1] This implementation of a real-time market is not capable of fully addressing ancillary services and issues with reserves, since it implements only a single settlement for energy.

Reference Price

The first aspect of modeling AMP is the determination of the three screens. For our purposes, the only open question here is the determination of the *reference price*. We set this value to the marginal cost for each block of power or 25/3 $/MWh, whichever is more. Note that this automatically allows all bids below 25 $/MWh to pass, because the conduct price will be at or above this value.

Conduct Price

Let us define the *conduct price*, which is used in the conduct screen, to be 200 percent or 100 $/MWh above the reference price, whichever is less. This is according to the FERC ruling, which we quoted earlier.

Screening Process

Let us begin our description of the screening process by defining the two market clearing models that will be used to perform the price and impact screens. The *Normal Model* includes all of the bids as submitted to the market, while the *Mitigated Model* includes all of the bids that pass the conduct screen as submitted. The latter also includes all of the bids that do not pass the conduct screen at their reference prices[2]. Define Normal_MCP(z) and Mitigated_MCP(z) to be the market clearing prices for each of the respective models for each zone, z.

Step 1. Formulate and solve the Normal Model of the market-clearing problem.

Step 2. If for all zones, z, the values of Normal_MCP(z) are below the price screen of 91.87 $/MWh STOP. No mitigation is necessary.

Step 3. Formulate and solve the Mitigated Model of the market-clearing problem.

Step 4. For each zone, z, (internal or external to the state), define
Impact_MCP(z) = min[3*Mitigated_MCP(z), 50 + Mitigated_MCP(z)]

Note that we interpret a 200 percent increase in prices as being three times the mitigated value. We also interpret zones as being all of the ISO zones, both internal and external.

Step 5. If, for all zones, z, (internal and external to the state),
Normal_MCP(z) < Impact_MCP(z)
then STOP. No mitigation is necessary.

Step 6. Activate mitigation by utilizing the Mitigated Model to clear the market.

---

[2] Although not germane to our current study, due to the simple network model we are using, the bids from out-of-state suppliers should be set to zero in the Mitigated model

Note that this implies that all players who do not pass the conduct screen are treated as a block. On the one hand, this simplifies the screening process, while on the other it may punish the whole class for the actions of a single player.

This sort of broad-brush treatment is fertile ground for the formation of a facilitating mechanism for collusion. According to theory [10,11], for an implicit understanding among market participants to be incentive compatible, there needs to be an enforcement mechanism. One such understanding could be to raise prices above the conduct price, but not so high as to trigger mitigation. That is, to exercise market power.

AMP could facilitate enforcement, whereby it helps to organize two essential ingredients of an enforcement mechanism: detecting that a player has broken ranks and extracting punishment in as obvious a manner as possible. Detection can be achieved by observing market prices, and AMP triggering can act as the punishment, with the signal being very clear to all market participants that mitigation has been occurred. These ingredients are possibly strong and clear enough to organize collusion only implicitly. That is, there would be no need for participants to explicitly communicate their intentions.

Another important aspect of the screening is that mitigated bids are set to the reference price. Recall though that only bids above the conduct price are mitigated. These two facts combined create a discontinuity in revenues as a function of the bid price, which is characterized by the activation (or not) of mitigation. The presence of such a discontinuity creates strong incentives to avoid it, further altering the bidding behavior of market participants. We present a simple example later as we discuss agent behavior.

Settlement Process

Through the screening process, it was necessary to compute mitigated bids and to clear the market accordingly. This means that settlement will occur as a result of either the Normal or Mitigated Model in the usual fashion. That is, each supplier is paid the nodal MCP and each demand pays the nodal MCP. When the nodal MCPs differ, appropriate congestion payments are made to the owners of transmission rights.

The DEC Game

There is an aspect of AMP we should mention that is not addressed in this study, yet is part of the mitigation of local market power. It is commonly known as the DEC Game. FERC and the CA-ISO share the concern that using a zonal pricing method can allow out of merit dispatch to be used as a lever for market power under conditions of intrazonal congestion.

FERC ruled (see Paragraphs 90 to 93) in this case that the usual AMP should be applied, but settlement is problematic in that it pays the owner of the out-of-merit unit the *higher* of the reference price or MCP, the principle being that the out-of-merit unit cannot set the MCP. Since the payment can be higher than the MCP, this settlement rule can lead to revenue deficiency that would probably be uplifted.

The DEC game is a two-settlement process, utilizing two different network models. The difference in the two network models yields incentives to game the market. Our experiments use a single settlement process, which places the DEC game beyond the scope of this study.

Agent Behavior

We have configured the agents in an attempt to eliminate experimental bias. First, the demand players, as mentioned, always bid their willingness-to-pay. This makes them price takers. The suppliers exercise all of the strategy in our simulation, and each one uses an identical strategy of aggressive profit maximization. They can detect whether they are pivotal players through the use of the available information and will attempt to bid at the price cap if it will increase profits.

Agents know their own costs, and based on the rules of AMP they can compute the conduct price for each block of power they bid into the market. Thus, when AMP is activated, the agents know that they can bid as high as their conduct prices without having their bid changed. They will also attempt to bid higher than their conduct prices in search of the impact price, which could yield even higher profits.

Agents know when they are marginal suppliers by comparing their bid prices with the market-clearing price. As such, marginal suppliers utilize a very simple naïve rule as a greedy algorithm for rent capture. The rule is that, when they are marginal, they test the margin by raising their bid prices.

Agents have the opportunity to bid and learn the market clearing price and their schedules thirty times. During these thirty rounds of bidding, they learn whether the market is more or less competitive and respond accordingly by switching between strategies that essentially raise either their sale prices or quantity sold in an effort to increase profits. Thus, we refer to them as having strategies for increasing profits based on either price or quantity.

The role of learning is captured in the way that rounds of bidding are repeated for all of the suppliers. In reality, one may say, that this type of repetition does not in reality occur. Indeed, scarcity events may be rare in occurrence in actual markets. On the other hand, market simulation itself can make frequent in the laboratory what is rare in reality. Thus, we believe it is not only fair, but also important, to offer agents occasions to learn in order to properly simulate real market behavior.

Typical Bid Curves

To offer an idea of how bids are formed and submitted to the market, Figure 2-2 depicts the bid curves under one scenario for our three types of equilibria. In this scenario, demand is 19,000 MW, and the transfer capability is 2,000 MW.

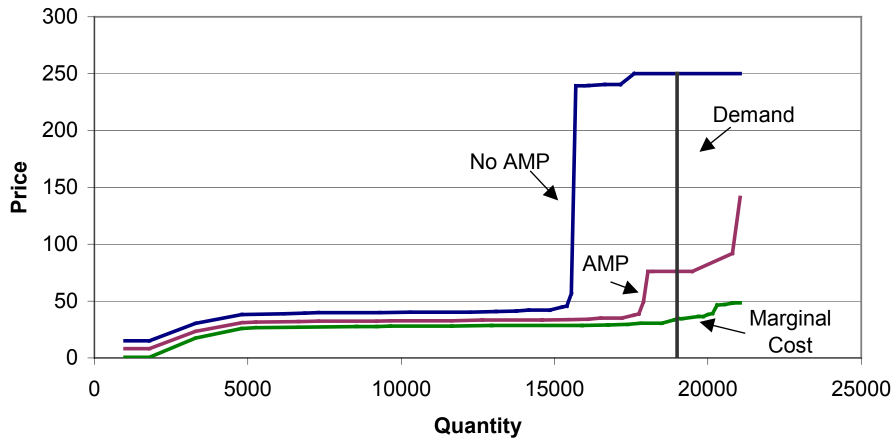

Figure 2-2
Final Bid Curves for 19,000 MW Demand and 2,000 MW Transfer Capability

The vertical line is the demand and, since there is no congestion, we can tell that the clearing prices ($/MWh) in these three cases are: No AMP – 250.0, AMP – 76.5, and Competitive – 34.5. Five players know that they are pivotal in this scenario, and enough of them bid at their perceived bid caps to make the supply curve horizontal around the demand level.

Pivotal suppliers initially bid all or most of their resources at the price cap (250 $/MWh), but throughout subsequent rounds they typically learn that they have competition or that mitigation is possible, depending on the scenario. As a defensive strategy, they then will bid fewer of their resources high, holding some low to ensure that they are not entirely locked out of the market. Thus, bids far away from the margin are being affected by the presence of AMP.

There are also free riders. Some pivotal players decide that, since they are not on the margin or otherwise unable to affect prices directly, they will instead bid low. They choose to let others take the risks.

Effect of Mitigation on Bidding Strategy

We now present a very simple example of the effect that the possibility of mitigation can have on a participant's behavior. In this example, we consider a case of a participant deciding how to bid a block of power with reference price equal 2, conduct price equal 6, and impact price equal 18. Figure 2-3 contains the mappings of bid price to Expected MCP Floor for different probabilities that another player will trigger the mitigation. We define the Expected MCP Floor as the lowest value that the player could receive for their block of power. That is, they should only receive a price lower than their bid when mitigation is triggered.

When no other player is likely to trigger mitigation (p = 0.0), the Expected MCP Floor will be equal to the bid, up until the participant herself triggers it by bidding above the impact. When mitigation is certain to occur (p = 1.0), the Expected MCP Floor drops off as soon as the participant bids above the conduct price. The other two cases depict combinations of these first two cases based on the probability of mitigation.

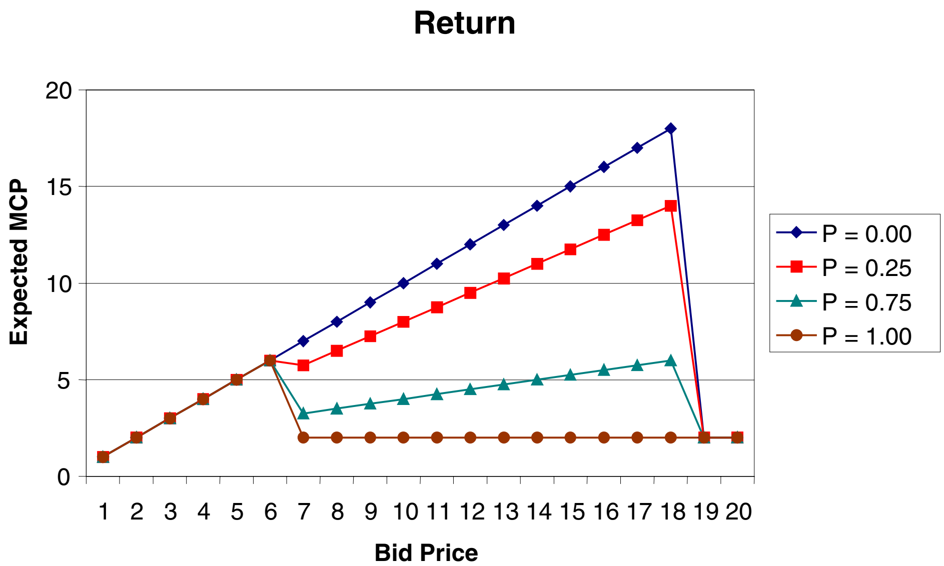

Figure 2-3
Return Functions for Different Probabilities of Mitigation

To simplify our strategy discussion, let us assume that the player is certain to be accepted at a constant quantity no matter what they bid. Let us also assume that the participant is the marginal player and thus sets the MCP, so that the Expected MCP is the same as their Expected MCP Floor.

The bidding strategy of the participant should then be obvious for each value of the probability of mitigation. It is to bid the price that achieves the highest Expected MCP. For small values, the strategy would be to bid just below to the impact price, while for large values the strategy would be to bid just below the conduct price. While this example is highly simplified, we believe that it displays the essential elements of the bidding decision, and thus the general framework of a valid bidding strategy.

3
EXPERIMENTAL RESULTS

The scenarios are solved four times for different types of market equilibria. As results, we present market-clearing prices for the competitive equilibrium, the monopoly solution, the simulations with AMP, and the simulations with no AMP. All simulated prices for the AMP and No AMP results are for the average of the last five rounds of bidding by agents.

Competitive Prices

Competitive prices are obtained by having the suppliers bid their marginal costs. In Figure 3-1, we can see that the main feature of this type of bidding is that as demand increases, the price curve outlines the marginal costs of the suppliers. Also, as the line capacity between the two nodes decreases, the North and South markets begin to separate. The Southern market is relatively high priced compared to the Northern one, and the continued separation of the two markets causes the price curves to more and more represent the individual marginal cost curves of the regions. Thus, the prices in the North tend to go down, and those in the South tend to rise up, with decreasing line capacity. The numerical values can be found in Appendix A, Data Tables.

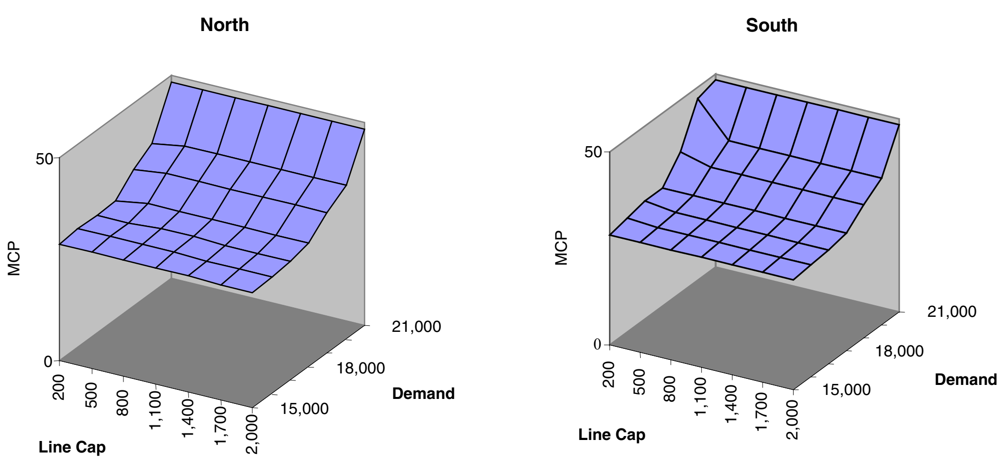

Figure 3-1
Competitive Prices for all Scenarios

These competitive results will later be contrasted with simulated results in order to understand the impact of AMP and its effectiveness. First, a look at the Monopoly Solution will help us to understand the bidding strategy for AMP.

Monopoly Solution

Without AMP, a monopoly player can exercise a strategy to maximize profits by bidding at the price cap for all of our scenarios. This is a trivial result. Congestion is not an issue, because all nodal prices will be equal.

With AMP present, the situation is more complex. First is the question of how to simultaneously raise the Mitigated_MCP and the Normal_MCP through strategic bidding. Second is the question of what effect congestion may have on bidding.

When there is no congestion, the following strategy can raise both MCPs together. Bid the quantity Demand - ε at the conduct_price(u) of the unit, u, and bid the quantity Supply – Demand + ε at min (3p, 50 + p), where p is the conduct price of the marginal economic unit, and ε is a small positive number. Thus, the bid curve will look like that in Figure 3-2. The curve for Marginal Cost, shown for reference, uses the same dispatch order as the bid curve.

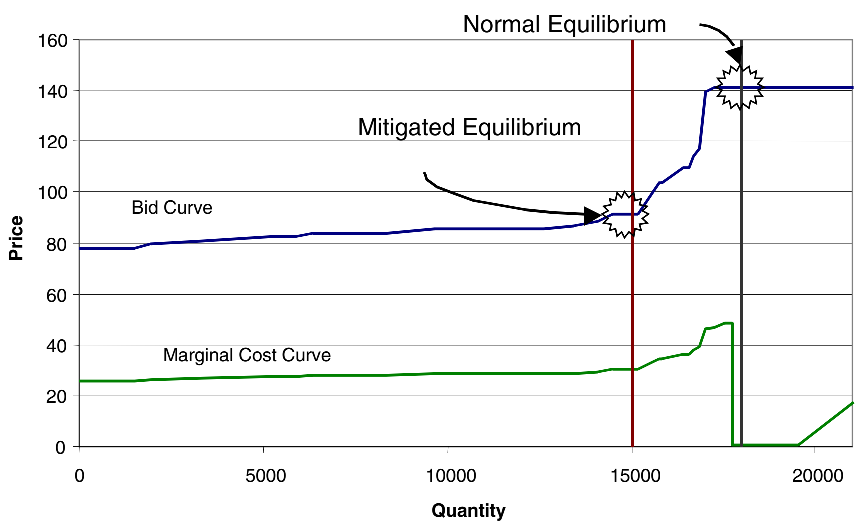

Figure 3-2
Bid Curves for a Monopolist under AMP

Note from the figure that high-cost units will be bid lower than low-cost units, so as to use the highest possible conduct price to set the Mitigated_MCP. Note also that this strategy only works when Demand > Supply/2, but this is true for all of our scenarios. The scheme can also fail when the costs of the high-cost units are so high that they lead to lower overall profits at the Normal_MCP. This is not true for the system we model here.

When the line capacity drops and causes congestion, the strategy changes only slightly to accommodate local import and export restrictions as follows. The highest cost unit in each node determines the direction of flow, and then the demand level is modified in each node to yield the residual demand. Finally the above strategy is executed on this residual demand for each node.

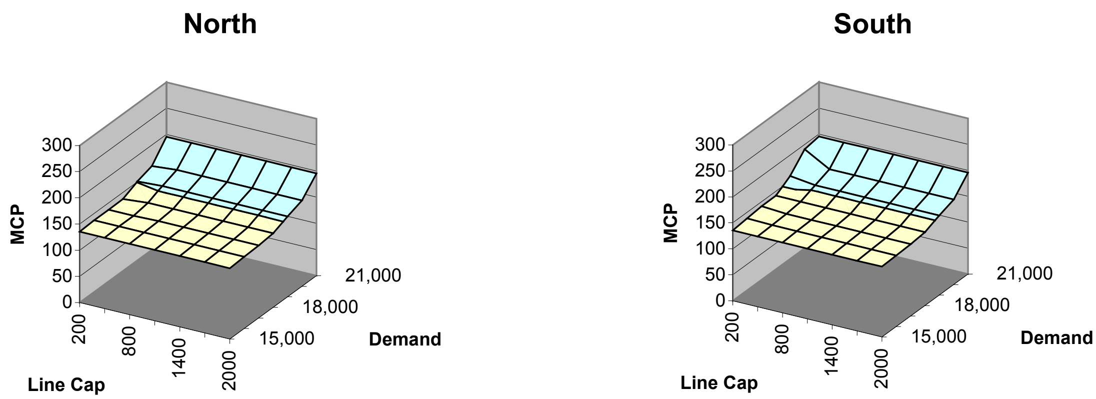

Figure 3-3
Monopoly Prices under AMP for all Scenarios

Figure 3-3 contains a chart of prices that could result. These were computed directly from the competitive results by incrementing the competitive price to the conduct price and on to the impact price, assuming that the reference prices of each block of power are set to the marginal cost. Each increment is a monotone, increasing mapping from the lower to the higher price. To compute the Monopoly prices this way, we need to assume that a monopolist is free to dispatch at least cost (despite the fact that low-cost units were bid out of the market), so that the monopoly power flow is identical to the competitive one. Only the price is different. The monopoly price is guaranteed to be equal to the impact price as calculated in this procedure, because the bidding strategy is always effective over this range of scenarios.

If the dispatch is tied to market acceptance, then the Monopoly bidding problem is much more complex. We have not implemented this approach, because we feel that the provided results act as a sufficient benchmark for much less effort.

No-AMP Prices

Automated simulation results over the scenarios yield essentially two phases of market behavior. The first phase occurs when there is sufficient reserve margin (supply minus demand) and transfer capability to cause the suppliers to compete with each other. We will refer to this as the *quantity phase* for the reason that a sufficient number of participants are executing a strategy to maximize their quantity sold. In the alternative phase, the suppliers do not compete and raise prices close to the maximum of 250 $/MWh. We will refer to this as the *price phase* of market behavior, because a sufficient number of participants are executing a strategy to maximize their sale price. Figure 3-4 contains charts of the market-clearing price at the North and South nodes for all of the scenarios.

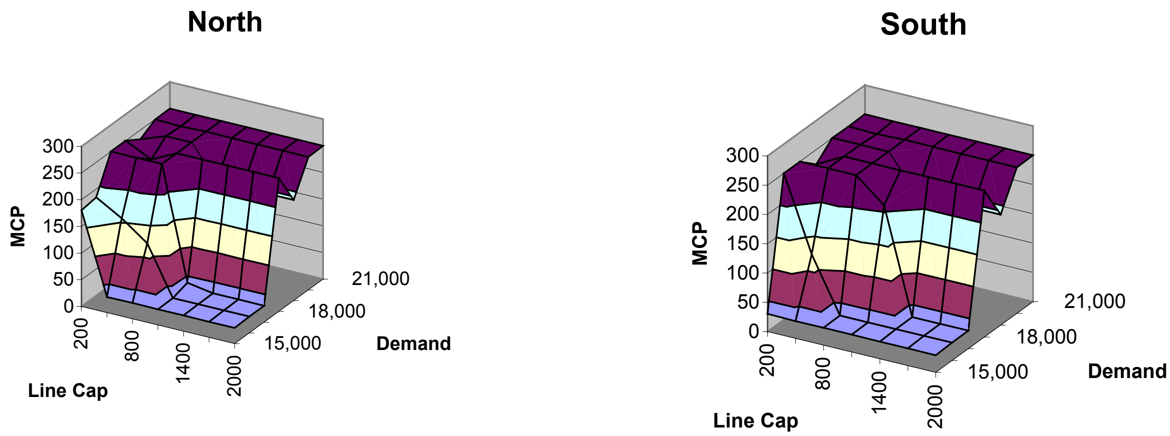

Figure 3-4
Simulated Prices without AMP for all Scenarios

These surface plots show very similar behavior in both of the regions for the same scenarios. They are also reminiscent of the surfaces in Figure 2-1, counting the pivotal players. The competitive region in the South does coincide with the lack of pivotal players. The same region in the North is very similar. It indicates that northern suppliers are able to enjoy high prices, simply because they are high in the adjacent region, even when no Northern supplier is pivotal. This occurs, naturally, when there is no congestion. With congestion present, the situation is more one of a marginal northern supplier seizing the opportunity to raise the northern MCP.

At a macro level, the boundary between the quantity and price phases of market behavior is well delineated (at least at this scale). The market is clearly behaving one way or the other, the two phase-regions are contiguous, and the transition from one to the other is unambiguous.

AMP Prices

The charts in Figure 3-5, which depict market-clearing prices for our AMP simulations, depict the same two phases of market behavior. Prices are also lower due to the effect of the mitigation procedure. When demand is above 19,000 MW, the last few production units are able to raise the market clearing price to somewhere between 150 and 200 $/MW. These values are a direct result of strategic bidding with the highest cost units. In fact, when the demand reaches 21,000 MW, leaving reserve capacity of only 50 MW, the MCP finally reaches the monopoly price.

At the macro level, the transition between price and quantity phases is more ambiguous than in the previous case. The competitive region (quantity phase) is still clear, but the market no longer jumps rapidly to the price phase. There is now a significant *phase transition region*. We will investigate this further in the following.

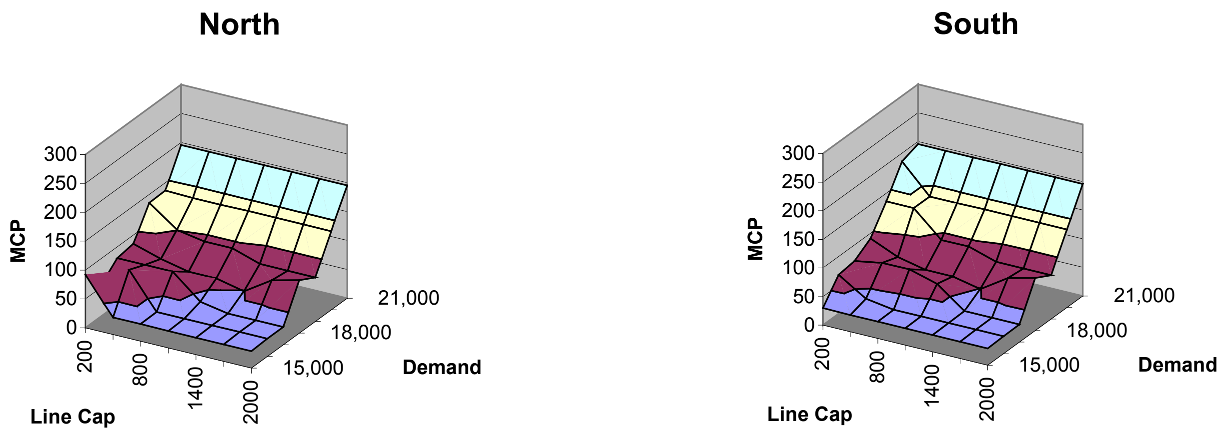

Figure 3-5
Simulated Prices with AMP for all Scenarios

Effectiveness of AMP

Having reviewed the fundamental simulation results, we now turn our attention to investigating the effectiveness of AMP in promoting competition. Our threshold for competitiveness will be based on conduct prices. Let us define Conduct_MCP(z) to be the market-clearing price for zone z, when all of the bids are at the conduct price. Theoretically, AMP attempts to at least keep prices below this level when there is market power. When prices are above Conduct_MCP(z), the market is clearly non-competitive.

Figure 3-6 shows AMP prices with the Conduct_MCP(z) subtracted off. The point of these drawings is that, under some non-competitive conditions, the agents are effective in getting the market-clearing price well above the conduct price.

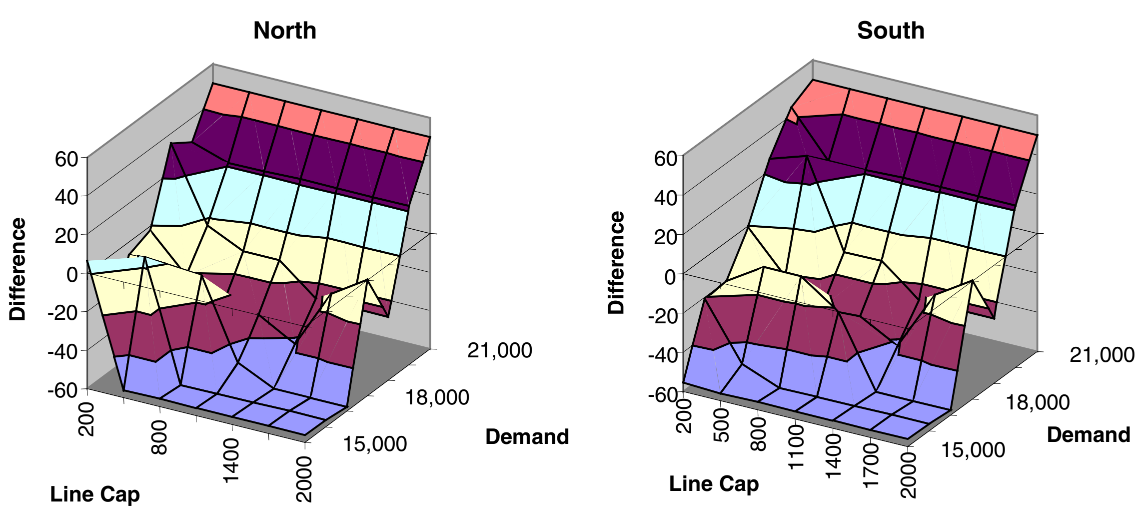

Figure 3-6
Simulated AMP Prices relative to the Conduct Price

Earlier we mentioned that a key ingredient of market behavior is the presence of pivotal players. In Figure 3-7, we depict topologies of the number of pivotal players for all of the scenarios. We will compare these topologies directly with price-based ones to discern the effectiveness of AMP. Note that, in the South, there is no scenario where there is only one pivotal player. Also, in the South, there is only one scenario with four pivotal players.

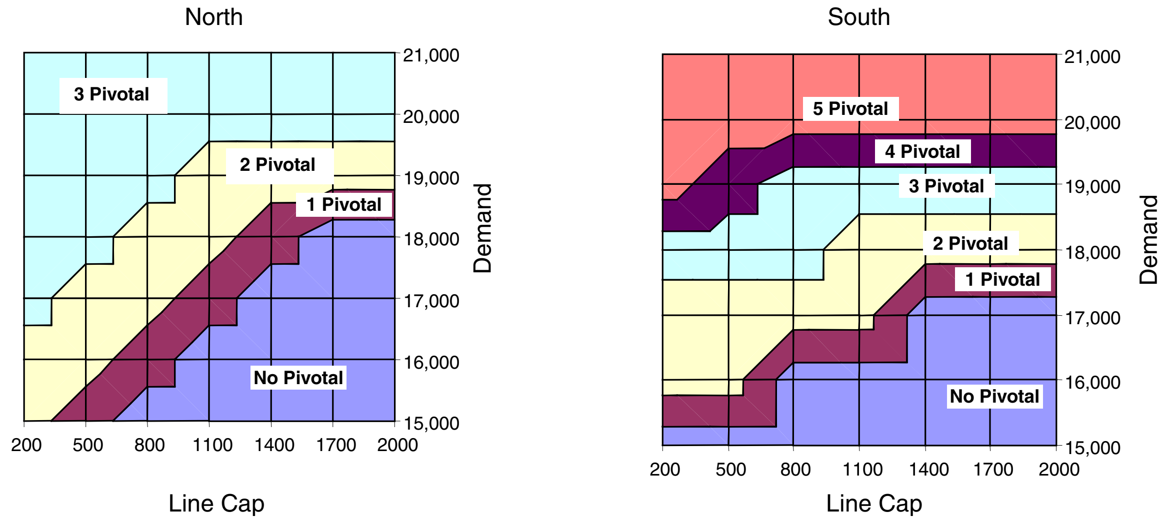

Figure 3-7
Topology of Pivotal Players in the North and South across Scenarios

Figure 3-8 shows a two-dimensional grid of the 49 scenarios and has them colored according to whether the MCP is above or below a threshold value and whether prices differ from the No-AMP case. Thus, the region labeled Price Phase has prices above the greater of the conduct price or 91.87 $/MWh, and the region labeled Quantity Phase has prices identical to the No-AMP case. The Transition Region consists of scenarios with prices below our threshold value, which were impacted by the presence of AMP.

It is clear that with AMP, more scenarios are competitive. AMP seems fairly effective at getting the computer agents to compete with each other even under very restrictive conditions on the transfer capability between the regions. This is probably because of the degree to which AMP reduces the maximum achievable market-clearing price.

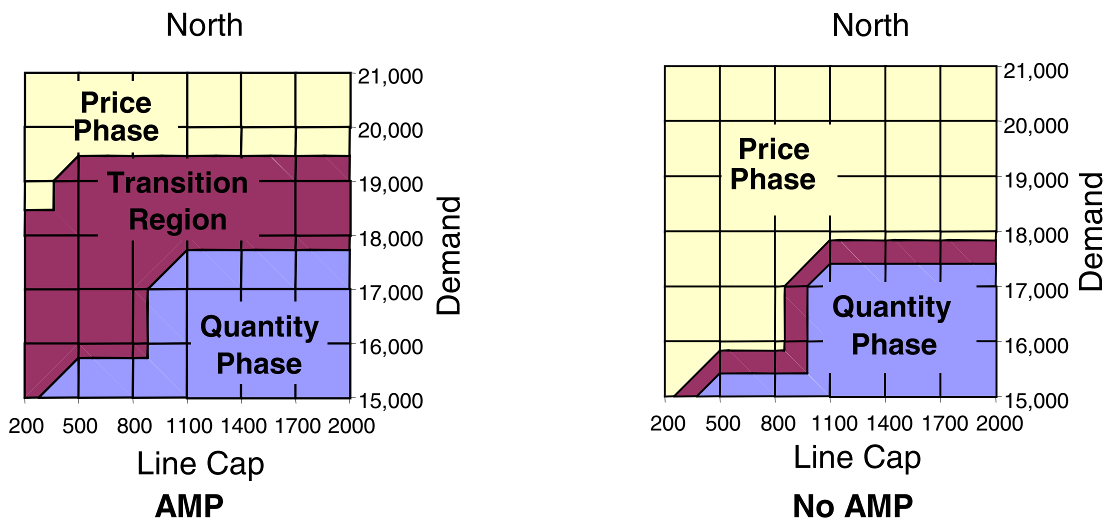

Figure 3-8
Comparison of Competitiveness in the North with and without AMP

Without AMP, suppliers are better able to make more profit by raising prices than by competing for market share. This is of course a result that is sensitive to the way that the various screens are devised and to the resource and ownership structure of the market model. It may be worth more effort to test these sensitivities of AMP.

Also from Figure 3-8, we can see that in 35 out of 49 scenarios, the Northern MCP is higher than our threshold value of the marginal bidder with no AMP in place. When AMP is present, the number of non-competitive scenarios drops from 35 to 15. For the region we have studied, this is a significant difference. To really test the significance of this effect, one would need a more-realistic market model and to correlate scenarios with load duration statistics. Then one can better assess the real life impact of AMP in promoting competition.

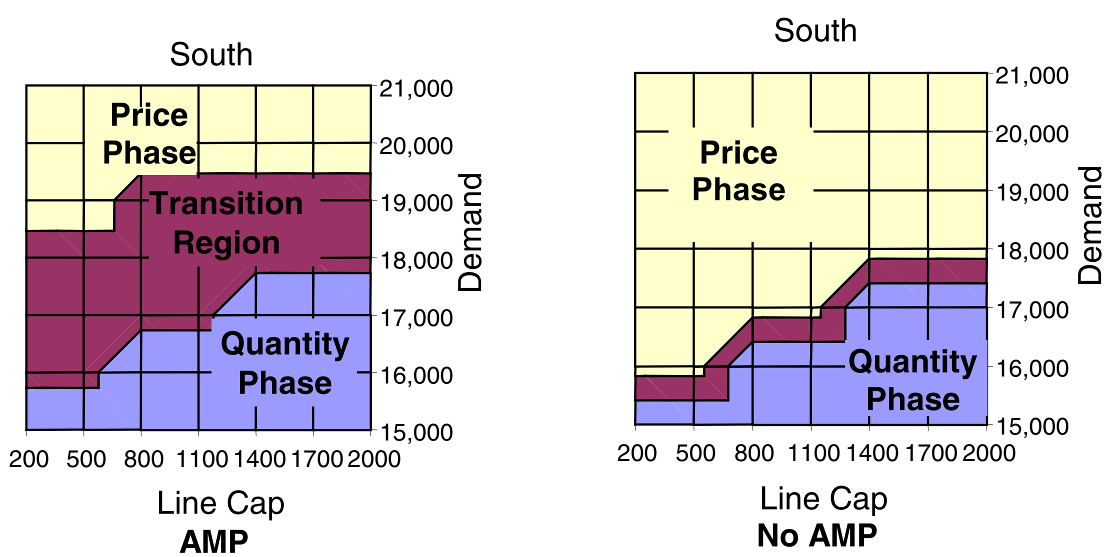

Figure 3-9
Comparison of Competitiveness in the South with and without AMP

In similar results for the South, the No-AMP pattern mimics the one for pivotal players in Figure 3-7. The AMP competitive pattern is similar to the North pattern. AMP reduces the number of non-competitive scenarios from 34 to 16 in the South.

Oligopoly and Scarcity Rents

Early in our introduction, we cited the FERC ruling regarding the purpose of AMP being to "limit market power, not to suppress prices during scarcity conditions." We have already seen that AMP reduces prices and thus supplier profits under scarcity conditions. In this section, we will investigate the distribution of oligopoly and scarcity rents along the lines of [9] (see Appendix for details). We calculate oligopoly rents as being the portion of supplier profits derived from market prices being above the marginal cost of supply, by node. Naturally, in the competitive case, this difference is zero, and there are no oligopoly rents. Figure 3-10 compares the oligopoly rents with and without AMP.

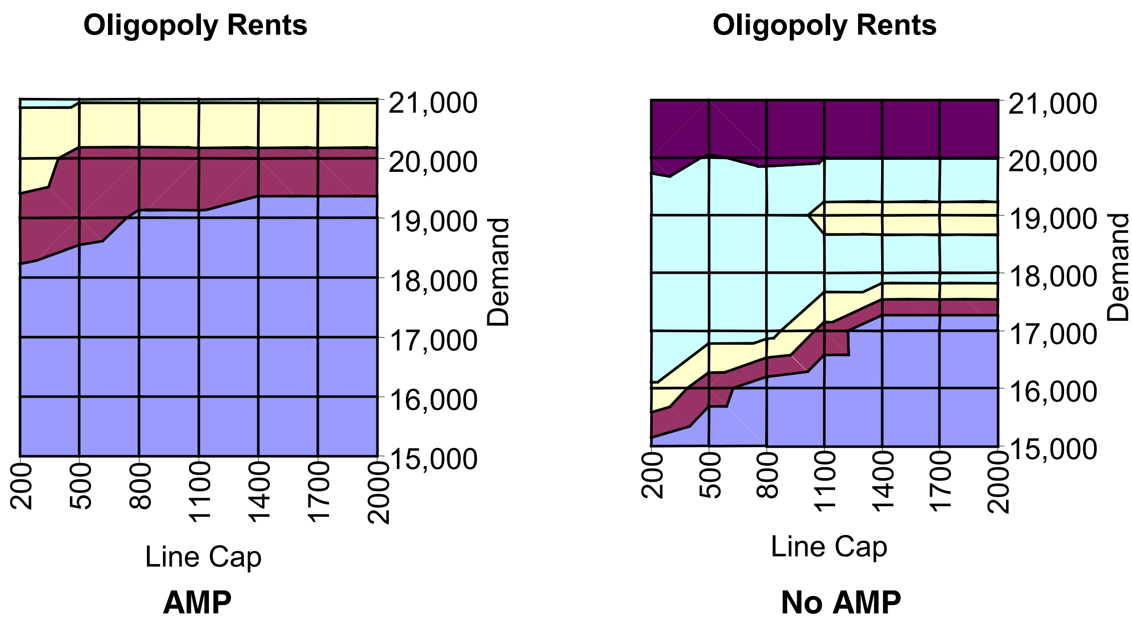

Figure 3-10
Oligopoly rents with and without AMP

We can quickly corroborate the difference that AMP has made on supplier profits. With AMP present, oligopoly rents average in at 966,843, whereas without AMP the average is 2,503,422. This is a substantial effect. Table 3-1 summarizes these statistics on oligopoly rents and contains the median in addition. Recall also that our Monopoly case includes AMP.

Table 3-1
Statistics on Oligopoly Rents

	Competitive	Monopoly	With AMP	Without AMP
Minimum	0	1,605,000	1,641	1,641
Maximum	0	3,087,000	3,087,000	4,231,500
Mean	0	2,155,585	966,843	2,503,422
Median	0	1,998,000	554,895	3,432,249

The second aspect of the FERC statement regards scarcity of resources. We use scarcity rents to represent the ability of suppliers to reap additional profits due to scarcity conditions. The value of the supplier scarcity rent is the supplier profits minus their oligopoly rents. Figure 3-11 compares scarcity rents with and without AMP.

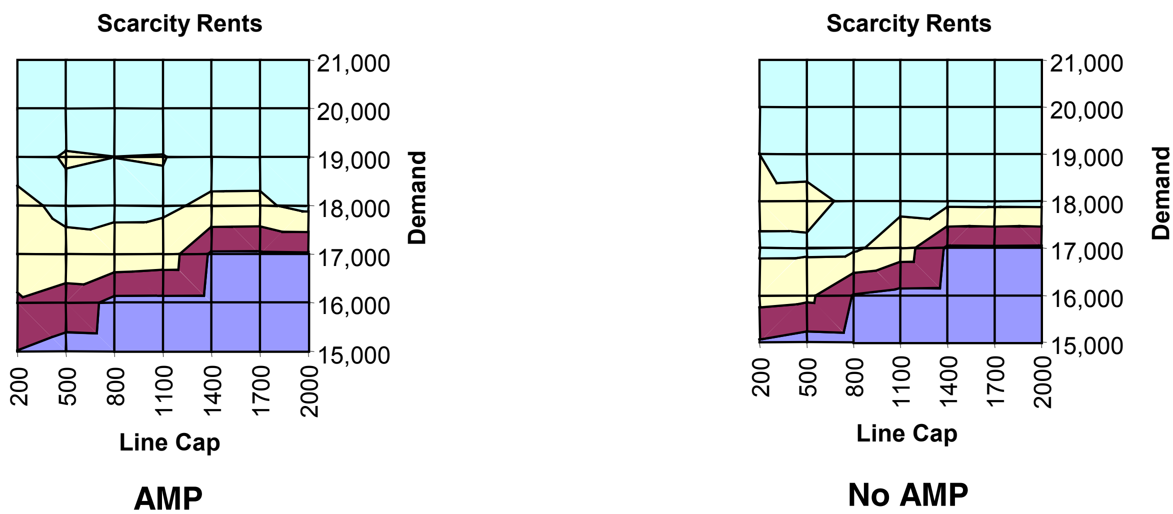

Figure 3-11
Scarcity rents with and without AMP

Also, Table 3-2 gives related statistics for these two cases plus the competitive case.

Table 3-2
Statistics on Scarcity Rents

	Competitive	Monopoly	With AMP	Without AMP
Minimum	77,425	77,425	78,825	78,825
Maximum	465,725	465,725	465,625	465,250
Mean	184,402	184,402	304,965	317,930
Median	111,150	111,150	364,337	396,060

The range of scarcity rents is little affected by market behavior. Minimum and maximum values are close to 78,000 and 465,000 in all cases. The mean and median values, however, tell a different story regarding the relation between the competitive equilibrium and the others. The competitive equilibrium always uses the most efficient dispatch, whereas the other cases do not. The reduction in average scarcity rents due to AMP is about $13,000 or 0.4%, which supports FERC's statement that AMP should not have much affect.

We have mentioned the incentive to bid low-cost resources high under AMP. This leads to higher supplier costs. It turns out that without AMP, dispatch is equally inefficient, leading to higher supplier costs and higher scarcity rents. The reason behind this is that suppliers are so often bidding the same price for their resources, that the dispatch determined by the market clearing mechanism is arbitrary with respect to true costs. Table 3-3 lists statistics for supplier costs that bear this out.

Table 3-3
Statistics on Supplier Costs

	Competitive	With AMP	Without AMP
Minimum	350,075	350,085	350,085
Maximum	552,775	552,875	553,270
Mean	443,391	451,254	451,333
Median	437,850	450,259	454,150

In the larger scheme of things, the $10,000 difference in mean dispatch costs over these scenarios represents a 0.3% decrease in dispatch efficiency. This is clearly a second order effect. Ironically, it is also evidence that the incentives under AMP to bid low-cost units high are not making the dispatch worse than when AMP is not present.

Transmission Congestion Rents

One aspect of these experiments is not related to AMP, but its apparition is hard to ignore. It is the relationship between congestion rents and supplier profits. To investigate, we will look closer at the scenario where demand is 17,480 MW and transfer capability is 1400 MW.

Figure 3-12 is a plot of the series of prices obtained in 30 rounds of bidding by agents. The series show prices for the North and South nodes. For the first ten rounds, a pivotal southern supplier is alternating between being mitigated and not. Eventually, by round eleven, the southern supplier finds a price just below 91.87 where no mitigation occurs. Then the marginal northern supplier begins to raise its price until it reaches the southern MCP. By round 18, the markets are unified, and all suppliers are competing causing the MCP to drop. At round 28, a pivotal southern supplier decides that if the MCP drops lower, they will loose too much profit, and again bids close to 91.87. Finally, in round 30, a southern supplier bids above 91.87, triggering mitigation.

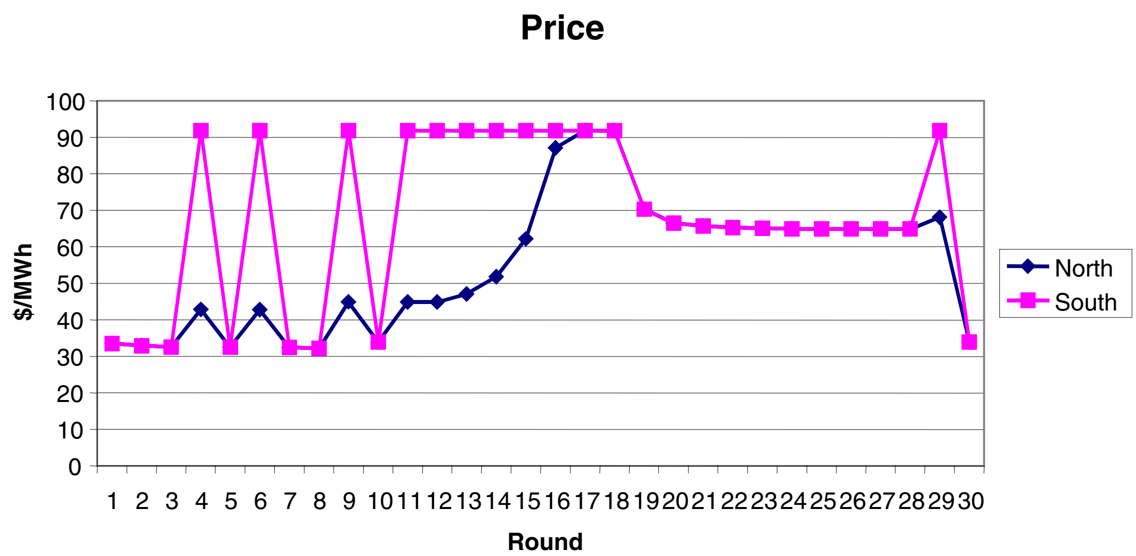

Figure 3-12
Nodal Market Clearing Prices over 30 Rounds of Bidding

Another way to look at the situation is that the Northern suppliers are able to extract congestion rents away from the holders of the Transmission Rights. Figure 3-13 shows the value of the profits distributed between these two classes of market participants.

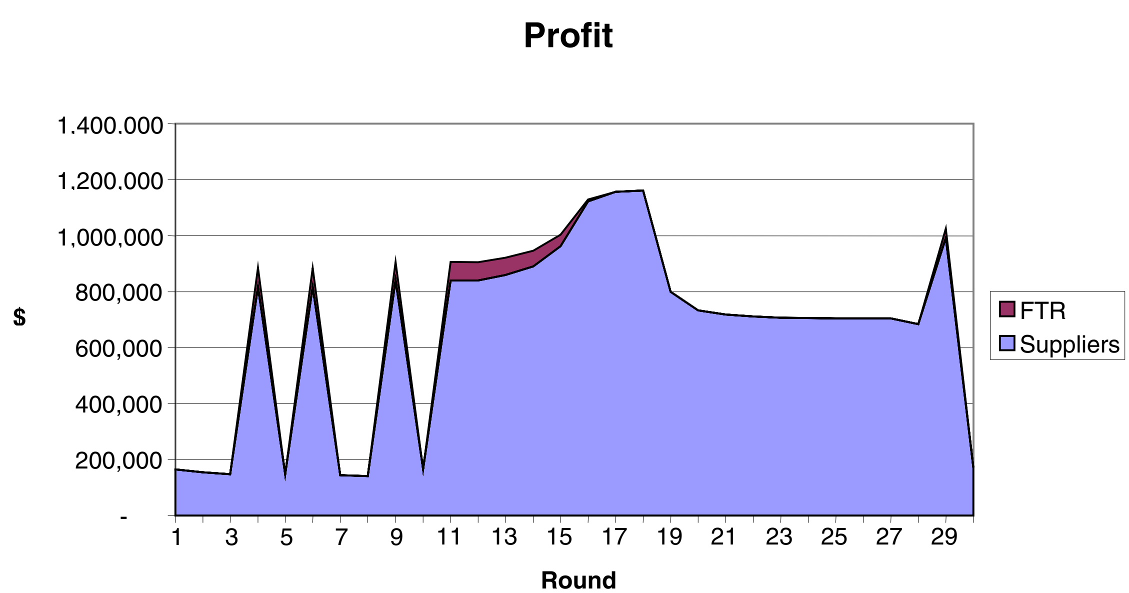

Figure 3-13
Redistribution of Profits between Suppliers and Transmission Rights Holders

The bottom layer in the chart is supplier profits and the thin upper layer is FTR revenue. Note that not only do Northern suppliers take rents from the transmission rights holders as they raise the North MCP closer to the South MCP, but they also make much more profits in proportion to the profits lost by FTR owners. This is because the amount of profits to be made on FTRs is limited by the 1400 MW of transfer capability, while the profits to be made by suppliers is on around 6800 MW of production. The ratio is more than 4 to 1 in this case. We should emphasize that the agent behavior of using a simple, naïve rule as a greedy algorithm is allowing this rent capture. The point being that it does not require some hugely sophisticated model to accomplish this task.

4
CONCLUSIONS

The obvious conclusion of this study is that AMP has the effect of a price cap and is effective in the short term at lowering market-clearing prices when supply conditions are tight or line capacity is reduced. This reduction does not seem to differentiate between scarcity and market power. In the long-term, the lack of differentiation between scarcity and market power could lead to a capacity shortages if the price reductions are too severe, because of the reduced incentive for new investment.

The presence of pivotal suppliers and the reference prices of the highest cost units are the determining factors for non-competitive prices. There was a significant reduction in the number of non-competitive scenarios attributable to AMP, but more-realistic simulations, coupled with load duration statistics are needed to judge the true magnitude of this impact.

Beyond the obvious lay several more subtle insights, for instance:

- Even simulation agents, acting without explicit collusion or super-sophisticated analytical tools, can (besides capturing congestion rents) manage to avoid triggering the impact screen and therefore drive prices considerably above the levels of the conduct screen.

- As structured in our scenarios, AMP is effective in promoting more competition in the short term than would be the case without it. This is because it has the same effect as a price cap, and thus suffers the same liability of reducing long-term incentives for investment. In the long term, AMP may be responsible for inadequate capacity if not managed very carefully. A more realistic model and correlation to load duration statistics is needed to better assess how much more competition results from AMP.

- Suppliers in this simple two-node example are quite able to extract congestion rents. This is especially true when supplies are so tight that there are pivotal suppliers in both regions.

- Bidding behavior very much depends on AMP. AMP does not simply reduce bids in particular circumstances, it changes the incentives to exercise market power and hence indirectly changes bids in situations where no bids are mitigated directly.

- A careful design of AMP would account for its potential use as a facilitating mechanism. That is, certain market participants could trigger AMP or threaten to trigger AMP as a means of extracting benefits they would not otherwise obtain.

One of the main benefits of simulation derives from improving our understanding of how a particular AMP implementation reduces incentives to exercise market power. This was evident in the figures that showed the regions of pivotal players and non-competitive behavior. Detailed inspection of agent bidding practices showed that AMP increases the risks of bidding high, further confounds the decision-making process, and reduces the level of the maximum achievable price. All of these factors combine to make the market we have modeled more competitive under AMP.

The FERC statement that AMP reduces market power while not suppressing prices under scarcity conditions is supported by the evidence that AMP introduces a level of uncertainty that manifests a large transition region between two phases of market behavior: a competitive phase and a non-competitive phase. In severe conditions of scarcity, the market behavior approaches that of a monopoly that is restricted by AMP. This supports FERC's statement that prices can rise under scarcity conditions. The evidence also shows that oligopoly rents are substantially reduced, on average, while scarcity rents are little affected.

In the future, we expect to extend our studies in directions that include the use of more realistic market data, which will offer an opportunity to further test both the methodology and conclusions. Looking forward, proper treatment of AMP requires much more than contrived examples. We believe that valuable lessons can be learned in the laboratory setting regarding the actual implementation of AMP based on more detailed and realistic models and scenarios of the market.

5
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A
DATA TABLES

Supplier Resources

The following table describes the detailed cost structure of the eight supply portfolios. Our model uses the Total Variable Cost for each block of power (Unit) and ignores the Fixed O&M Costs.

Table A-1
Resource Information for Market Participants

Unit Name	Location	Capacity MW	Marginal Cost $/MWh
Portfolio 1			
Alamitos 3-6	South	1900	27.5
Alamitos 7	South	250	47.0
Huntington Beach	South	450	26.5
Redondo	South	1300	28.5
Total		*3,900*	
Portfolio 2			
EL Segundo 1&2	South	400	30.5
EL Segundo 3&4	South	650	27.5
Long Beach	South	550	36.5
Total		*1,600*	
Portfolio 3			
Morro Bay	North	1000	28.5
Moss Landing	North	1500	26.0
Oakland	North	150	39.0
Total		*2,650*	
Portfolio 4			
Coolwater	South	650	29.5
Etiwanda	South	1000	28.5
Ellwood	South	300	48.5
Mandalay	South	450	28.0
Ormond Beach	South	1400	27.0
Total		*3,800*	
Portfolio 5			
Hunters Point	North	400	33.5

Unit Name	Location	Capacity MW	Marginal Cost $/MWh
Pittsburgh	North	2000	28.0
Portrero Hill	North	150	36.5
Total		*2,550*	
Portfolio 6			
North Island	South	150	46.5
Encina	South	950	28.5
Kearny	South	200	48.5
South Bay	South	700	30.5
Total		*2,000*	
Portfolio 7			
Big Creek	South	1000	0.5
Mohave	South	1500	17.5
Highgrove	South	150	34.5
San Bernardino	South	100	34.5
Total		*2,750*	
Portfolio 8			
Contra Costa	North	850	29.0
Humboldt	North	150	38.0
Helms	North	800	0.5
Total		*1,800*	

Tables of Results

Table A-2
Competitive Prices for all Scenarios

Zone	Xfer Cap	Demand 19,000	18,240	17,480	16,720	15,960	15,200
North	2000	34.5	30.5	30.5	29.0	29.0	28.5
North	1700	34.5	30.5	30.5	29.0	29.0	28.5
North	1400	34.5	30.5	30.5	29.0	29.0	28.5
North	1100	34.5	30.5	30.5	29.0	29.0	28.5
North	800	34.5	30.5	30.5	29.0	29.0	28.5
North	500	33.5	30.5	29.0	29.0	29.0	28.5
North	200	33.5	29.0	29.0	29.0	28.5	28.5
South	2000	34.5	30.5	30.5	29.0	29.0	28.5
South	1700	34.5	30.5	30.5	29.0	29.0	28.5
South	1400	34.5	30.5	30.5	29.0	29.0	28.5
South	1100	34.5	30.5	30.5	29.0	29.0	28.5
South	800	34.5	30.5	30.5	29.5	29.0	28.5
South	500	34.5	30.5	30.5	29.5	29.0	28.5
South	200	36.5	30.5	30.5	29.5	29.5	28.5

Table A-3
Simulated Prices without AMP for all Scenarios

Zone	Xfer Cap	Demand 19,000	18,240	17,480	16,720	15,960	15,200
North	2000	250.0	250.0	217.4	32.2	30.6	30.0
North	1700	250.0	250.0	217.4	32.2	30.6	30.0
North	1400	250.0	250.0	42.8	32.2	30.2	30.0
North	1100	250.0	249.9	39.2	39.2	30.7	29.9
North	800	239.5	245.9	250.0	242.8	31.5	30.0
North	500	214.0	245.9	250.0	124.9	235.8	30.3
North	200	222.2	250.0	198.2	250.0	250.0	212.7
South	2000	250.0	250.0	217.4	32.2	30.6	30.0
South	1700	250.0	250.0	217.4	32.2	30.6	30.0
South	1400	250.0	250.0	217.7	32.2	30.2	30.0
South	1100	250.0	250.0	250.0	179.6	30.7	29.9
South	800	250.0	250.0	250.0	250.0	30.8	30.0
South	500	250.0	250.0	250.0	250.0	173.3	30.2
South	200	250.0	250.0	203.6	250.0	250.0	47.6

Table A-4
Simulated Prices with AMP for all Scenarios

Zone	Xfer Cap	Demand 19,000	18,240	17,480	16,720	15,960	15,200
North	2000	135.50	130.99	132.49	32.21	30.63	30.01
North	1700	135.50	130.99	132.49	32.21	30.63	30.01
North	1400	135.50	130.99	73.96	32.21	30.24	30.01
North	1100	135.50	87.77	39.24	39.23	30.69	29.89
North	800	125.50	133.19	62.40	102.50	31.52	29.96
North	500	144.33	130.87	135.50	94.38	48.21	30.29
North	200	138.21	135.50	135.50	128.00	134.00	134.00
South	2000	135.50	130.99	132.49	32.21	30.63	30.01
South	1700	135.50	130.99	132.49	32.21	30.63	30.01
South	1400	135.50	130.99	132.49	32.21	30.24	30.01
South	1100	135.50	133.99	132.50	127.70	30.69	29.89
South	800	125.50	135.50	130.99	132.50	30.77	29.96
South	500	141.50	135.50	135.50	130.99	124.54	30.23
South	200	159.50	135.50	135.50	130.99	132.50	39.82

Table A-5
Simulated Prices with AMP minus the Conduct Price for all Scenarios

Zone	Xfer Cap	Demand 19,000	18,240	17,480	16,720	15,960	15,200
North	2000	32.0	39.5	41.0	-54.8	-56.4	-55.5
North	1700	32.0	39.5	41.0	-54.8	-56.4	-55.5
North	1400	32.0	39.5	-17.5	-54.8	-56.8	-55.5
North	1100	32.0	-3.7	-52.3	-47.8	-56.3	-55.6
North	800	22.0	41.7	-29.1	15.5	-55.5	-55.5
North	500	43.8	39.4	48.5	7.4	-38.8	-55.2
North	200	37.7	48.5	48.5	41.0	48.5	48.5
South	2000	32.0	39.5	41.0	-54.8	-56.4	-55.5
South	1700	32.0	39.5	41.0	-54.8	-56.4	-55.5
South	1400	32.0	39.5	41.0	-54.8	-56.8	-55.5
South	1100	32.0	42.5	41.0	40.7	-56.3	-55.6
South	800	22.0	44.0	39.5	44.0	-56.2	-55.5
South	500	38.0	44.0	44.0	42.5	37.5	-55.3
South	200	50.0	44.0	44.0	42.5	44.0	-45.7

B
RELATED CALCULATIONS

The following sections contain procedures for the calculations related to the data presented in this report. These calculations can be applied individually to each scenario and to the results across all cases, where the cases are the competitive equilibrium, monopoly solution, simulation with AMP, and simulation with No AMP.

Pivotal Player

The calculation of pivotal players is relatively simple in our two-node case. Thus, it was possible to do this calculation using a spreadsheet. The more general case is complex and requires the formulation and solution of a linear program, which will not be presented here.

Our spreadsheet version begins with the following data as inputs:

Nodes, set containing the two nodes of the network,

Suppliers, set of suppliers,

location(s), nodal location of supplier, s

sales(n), electricity sales by node, n

generation_capacity(s, n), generation capacity by supplier, s, and node, n

line_capacity, capacity of the single transmission line

First we need to compute some intermediate data values.

generation_capacity(n), total generation capacity at node, n,
```
:= sum[s in Suppliers | location(s) == n,
        generation_capacity(s,n)]
```

generation_capacity, total generation capacity overall,
```
:= sum[n in Nodes, generation_capacity(n)]
```

sales, total sales overall,
```
:= sum[n in Nodes, sales(n)]
```

Our next calculation measures the gap between supply and demand for each node. This gap can occur between either the overall totals, or between the nodal values plus import capability. Our sign convention is that a positive gap indicates that there is sufficient generation capacity at the node to cover sales.

> supply_gap(n), supply shortfall at node, n,
> := min[generation_capacity – sales,
> generation_capacity(n) + line_capacity – sales(n)]

The value of supply_shortfall(n) is positive in all of our scenarios, since the total supply is 20,050 MW and the maximum demand value is 20,000 MW. Table B-1 contains the values of the supply shortfall for all of our scenarios, for both nodes.

Table B-1
Supply gap by Scenario and Node

		Demand						
Xfer Cap	**Node**	**21,000**	**20,000**	**19,000**	**18,000**	**17,000**	**16,000**	**15,000**
2000	North	50	1,050	2,050	3,050	3,495	3,819	4,143
1700	North	50	1,050	2,050	2,871	3,195	3,519	3,843
1400	North	50	1,050	2,050	2,571	2,895	3,219	3,543
1100	North	50	1,050	1,948	2,271	2,595	2,919	3,243
800	North	50	1,050	1,648	1,971	2,295	2,619	2,943
500	North	50	1,024	1,348	1,671	1,995	2,319	2,643
200	North	50	724	1,048	1,371	1,695	2,019	2,343
2000	South	50	1,050	2,050	3,050	4,050	5,050	5,907
1700	South	50	1,050	2,050	3,050	4,050	4,931	5,607
1400	South	50	1,050	2,050	3,050	3,955	4,631	5,307
1100	South	50	1,050	2,050	2,979	3,655	4,331	5,007
800	South	50	1,050	2,002	2,679	3,355	4,031	4,707
500	South	50	1,026	1,702	2,379	3,055	3,731	4,407
200	South	50	726	1,402	2,079	2,755	3,431	4,107

The last step is to compare the value of the supply gap to the amount of generation capacity of each supplier. Having suppliers active in only one location simplifies the calculation.

> pivotal(n), number of pivotal players at node, n,
> := sum[s in Suppliers | location(s) == n,
> (generation_capacity(s,n) > supplier_gap(n) ? 1 : 0]

When a supplier has capacity greater than the supply gap, it can potentially control the market-clearing price by bidding all of its capacity at the desired price. If there is only on pivotal player, this strategy will control the price. If there is more than one pivotal player, the one that bids the highest price on its capacity will control the price. Table B-2 contains the number of pivotal players for each scenario and node.

Table B-2
Number of Pivotal Players for each Scenario and Node

Zone	Xfer Cap	Demand 21,000	20,000	19,000	18,000	17,000	16,000	15,000
North	2000	3	3	2	0	0	0	0
North	1700	3	3	2	0	0	0	0
North	1400	3	3	2	1	0	0	0
North	1100	3	3	2	2	1	0	0
North	800	3	3	3	2	2	1	0
North	500	3	3	3	3	2	2	1
North	200	3	3	3	3	3	2	2
South	2000	5	5	3	2	0	0	0
South	1700	5	5	3	2	0	0	0
South	1400	5	5	3	2	0	0	0
South	1100	5	5	3	2	2	0	0
South	800	5	5	3	3	2	0	0
South	500	5	5	4	3	2	2	0
South	200	5	5	5	3	2	2	0

The presence of pivotal players is an important indicator for the ability of suppliers to control the market clearing price.

Rents

This section describes the process for calculating scarcity and oligopoly rents. The following are input data for this process.

Nodes, set containing the two nodes of the network

Suppliers, set of supplier

Tenders, set of blocks of power bid by suppliers

location(s) in Nodes, nodal location of supplier, s

sales(d,x,n), amount of sales for demand, d, transfer, x, and node, n

production(n,s,t), energy production for node, n, supplier, s, and tender, t

mc(n,s,t), marginal cost of production for node, n, supplier, s, and tender, t

mcp(n,s,t), market clearing price for node, n, supplier, s, and tender, t

Following are intermediate accounting-type calculations that are fairly transparent.

sales_cost(n), sales cost to the consumer for node, n,
:= sales(n) * mcp(n)

supplier_cost(n,s,t), supplier cost of production for node, n, supplier, s, and tender, t,
:= production(n,s,t) * mc(n,s,t)

supplier_revenue(n,s,t), supplier revenue for node, n, supplier, s, and tender, t,
:= production(n,s,t) * mcp(n,s,t)

supplier_profit(n,s,t), supplier profit for node, n, supplier, s, and tender, t,
:= supplier_revenue(n,s,t) - supplier_cost(n,s,t)

marginal_production_cost(n,s), marginal cost of production for node, n, and supplier, s,
:= max[t in Tenders | production(n,s,t) > 0, mc(n,s,t)]

system_marginal_cost(n), marginal cost of production for node, n,
:= max[s in Suppliers, marginal_production_cost(n,s)]

The next calculations home in on rents. First we need to know how much higher than cost did the marginal player at each node bid. Since the marginal player sets the market-clearing price, this is a matter of comparing that to the system marginal cost by node. We will call this difference the price gap.

price_gap(n), difference between the marginal bid price and marginal cost for node, n,
:= mcp(n) – system_marginal_cost(n)

Oligopoly rent is the portion of profits that are a result of bidding above marginal cost.

oligopoly_rent(n,s), oligopoly rent for cost for node, n, and supplier, s,
:= sum[t in Tenders, production(n,s,t)] * price_gap(n)

Table B-3 through Table B-5 give the oligopoly rents for each case, except the competitive one. By definition, oligopoly rents are always zero at a competitive equilibrium.

Table B-3
Oligopoly Rents for all Scenarios of the Monopoly Case

Xfer	Demand 21,000	20,000	19,000	18,000	17,000	16,000	15,000
2000	3,087,000	2,520,000	2,261,000	1,998,000	1,853,000	1,728,000	1,605,000
1700	3,087,000	2,520,000	2,261,000	1,998,000	1,853,000	1,728,000	1,605,000
1400	3,087,000	2,520,000	2,261,000	1,998,000	1,853,000	1,728,000	1,605,000
1100	3,087,000	2,520,000	2,261,000	1,998,000	1,853,000	1,728,000	1,605,000
800	3,087,000	2,520,000	2,261,000	1,998,000	1,837,168	1,728,000	1,605,000
500	3,087,000	2,498,100	2,237,483	1,984,521	1,814,595	1,725,942	1,605,000
200	3,087,000	2,761,179	2,322,007	1,993,029	1,917,972	1,740,676	1,605,000

Table B-4
Oligopoly Rents for all Scenarios with AMP

Xfer	Demand 21,000	20,000	19,000	18,000	17,000	16,000	15,000
2000	3,087,000	1,754,844	554,895	780,588	7,025	1,641	6,744
1700	3,087,000	1,754,844	554,895	630,309	7,025	1,641	13,140
1400	3,087,000	1,754,844	554,895	84,524	7,025	17,178	13,140
1100	3,087,000	1,754,844	879,559	237,056	211,442	17,178	9,459
800	3,087,000	1,740,000	878,143	237,056	603,004	10,186	9,573
500	3,087,000	1,740,000	1,488,386	409,932	613,214	272,625	9,609
200	3,087,000	2,477,388	1,660,600	809,882	554,162	380,255	263,578

Table B-5
Oligopoly Rents for all Scenarios without AMP

Xfer	Demand 21,000	20,000	19,000	18,000	17,000	16,000	15,000
2000	4,231,500	4,018,604	2,680,360	3,626,910	7,025	1,641	6,744
1700	4,231,500	4,018,604	2,680,360	3,626,910	7,025	1,641	13,140
1400	4,231,500	4,018,604	2,680,360	3,634,146	7,025	17,178	13,140
1100	4,231,500	4,018,604	2,680,360	3,640,079	1,703,193	17,178	9,459
800	4,231,500	4,029,960	3,828,443	3,640,079	3,432,249	381,532	9,573
500	4,231,500	3,987,604	3,828,443	3,563,167	3,432,249	1,448,723	9,609
200	4,231,500	4,082,832	3,779,244	3,404,447	3,432,249	2,946,674	681,796

Scarcity rents are that portion of profits that are a result of production costs being less than revenues at marginal cost. We calculate it simply as profit minus oligopoly rents.

> scarcity_rent(n,s), oligopoly rent for cost for node, n, and supplier, s,
> := supplier_profit(n,s) – oligopoly_rent(n,s)

Table B-6 through Table B-8 give the scarcity rents for each case. We assume efficient dispatch for the Monopoly case, so we combine those results with the Competitive one.

Table B-6
Scarcity Rents for all Scenarios for the Competitive and Monopoly Cases

Xfer	Demand 21,000	20,000	19,000	18,000	17,000	16,000	15,000
2000	465,725	253,625	185,550	111,150	93,750	85,375	77,425
1700	465,725	253,625	185,550	111,150	93,750	85,375	77,425
1400	465,725	253,625	185,550	111,150	93,750	85,375	77,425
1100	465,725	253,625	185,550	111,150	93,750	85,375	77,425
800	465,725	253,625	185,550	111,150	89,465	85,375	77,425
500	465,725	247,020	178,732	107,446	81,975	84,823	77,425
200	465,725	368,344	210,820	105,446	114,837	91,227	77,425

Table B-7
Scarcity Rents for all Scenarios with AMP

Xfer	Demand 21,000	20,000	19,000	18,000	17,000	16,000	15,000
2000	465,625	450,300	419,290	412,010	109,030	107,840	84,545
1700	465,625	450,300	419,290	355,030	109,030	107,840	78,915
1400	465,625	450,300	419,290	356,180	109,030	89,675	78,915
1100	465,625	450,300	371,060	392,070	323,572	89,675	83,295
800	465,625	449,101	374,536	392,070	342,100	92,550	85,361
500	465,625	449,454	364,337	407,606	333,985	194,785	78,825
200	465,625	384,772	426,818	339,599	288,814	239,472	122,958

Table B-8
Scarcity Rents for all Scenarios without AMP

Xfer	Demand 21,000	20,000	19,000	18,000	17,000	16,000	15,000
2000	465,230	459,755	422,530	412,940	109,030	107,840	84,545
1700	465,230	459,755	422,530	412,940	109,030	107,840	78,915
1400	465,230	459,755	422,530	411,650	109,030	89,675	78,915
1100	465,230	459,755	422,530	405,341	315,354	89,675	83,295
800	465,230	451,561	436,570	405,341	395,268	119,100	85,361
500	465,230	457,805	436,570	331,144	396,060	281,418	78,825
200	465,250	391,803	374,606	337,971	396,060	296,670	114,636

C
CA-ISO FILING

The following text, taken verbatim from the CAISO May 1, 2002 Filing [6], is provided as background for defining the structure and issues of surrounding AMP as an element of market design. Most text is easily identifiable from section and paragraph numbers. Some parts have the text *[snip]* added to remind the reader that a large section of text has been skipped. Please refer to the original reference for those portions.

Bid Screens and Mitigation. Beginning on October 1, the ISO proposes to implement individual resource bid screens and mitigation procedures in the day-ahead Residual Unit Commitment process and in the real time pre-dispatch process that occurs 45 minutes prior to the start of the operating hour. In the Comprehensive Design this procedure would also be applied to the integrated forward energy and congestion management markets. The procedure involves mitigating energy bids that (a) exceed an explicit threshold level and (b) have a material impact on projected market clearing prices. This mitigation element is similar to the Automatic Mitigation Procedures (AMP) utilized by the NY ISO, but would have more stringent bid and impact threshold levels. The ISO recommends that bid reference levels be based on historical bids for all resources. The ISO further proposes a bid threshold equal to the lower of a 100% increase from a resource's reference level or $50/MWh, and a market impact threshold equal to the lower of a 100% increase or an increase of $50/MWh in the projected real-time market clearing price. This procedure would apply to all bidders into the markets to which the procedure is applied. As the ISO gains experience with the bid screen and mitigation procedures and if the overall competitiveness of the ISO markets improves, the ISO will consider raising the bid and price impact threshold levels.

[snip]

5.11 Bid Screens and Mitigation

5.11.1 Introduction

This element is intended to protect against certain types of anti-competitive bidding behavior. FERC has already recognized certain types of anti-competitive bidding behavior. For example, in its April 26, 2001 Order, FERC conditioned public utility sellers' market based rates on not engaging in the following types of bidding behavior.

A. Bids into the ISO markets that vary with unit output in a way that is unrelated to the known performance characteristics of the unit (also known as "hockey stick" bidding).

B. Bids into the ISO markets that vary over time in a manner that appears unrelated to change in the unit's performance or to changes in the supply environment that would induce additional risk or other adverse shifts in the cost basis.

Under the April 26 Order, market participants engaging in this type of behavior are subject to increased scrutiny by the Commission and potential refunds, and could have their market-based rate authority subject to further conditions, including prospective revocation of market-based rate authority. To carry these provisions forward beyond September 30, 2002 and make them more enforceable, the ISO proposes to seek authority, similar to what FERC has granted to the NY ISO, to mitigate a suppliers bids automatically when a supplier's bidding behavior (a) violates explicit anti-competitive thresholds, and (b) has a material impact on market prices.

5.11.2 ISO Proposal

The ISO proposes to implement individual resource bid screens and mitigation in the Day-ahead and Hour-ahead energy markets (to take effect when the ISO implements these markets) and the ISO's real-time energy market. This approach would be very similar to the bid mitigation approach that the New York ISO uses to automatically mitigate bids under predefined circumstances in its Day-ahead energy market. For the October 2002 implementation, since the ISO will not run a forward energy market, the ISO proposes to implement this feature in the Residual Unit Commitment instead. Moreover, due to difficulty of implementing it in a 10-minute dispatch time frame starting October 2002, the ISO proposes to apply this measure also in the real time pre-dispatch time frame. The AMP will not be applied, however, if the ISO's day-ahead load forecast exceeds 40,000 MW.

In the NY ISO, economic thresholds for energy bids are set with respect to a resource specific reference level, which is based on the resource's historical competitive bids during similar hours and load levels and adjusted for fuel prices. The bid threshold used by the NY ISO is an increase of 300% from the reference level or $100/MWh, whichever is lower. Similarly, the NY ISO also uses a fairly generous threshold to determine whether the bids had a "material price effect." For example, the energy market impact threshold used by the NY ISO is whether the bidding behavior resulted in an increase of 200% or $100/MWh, whichever is lower, in the hourly day-ahead or real-time energy Location Based Marginal Price (LBMP) at any location.

Under the NY ISO bid screen and mitigation approach, if a supplier's bids were found to (a) violate explicit anti-competitive thresholds, and (b) have a material impact on market prices, the NY ISO has authority to prospectively impose "default bids" for the supplier for a period of time, not to exceed six months. However, the supplier is still eligible to receive the LBMP. The NY ISO mitigation approach has evolved to the point where they are now able to mitigate bids automatically in their Day-ahead energy market. Under this approach, if the mitigated bids result in a material decline in the LBMP, then the mitigated bids and the resulting LBMPs will serve as the final day-ahead market result. If the mitigated bids do not have a material impact on LBMPs, the original bids and the original LBMPs will serve as the final day-ahead market result. Since this automatic process prevents market impact in the day-ahead market, mitigation is not applied prospectively beyond the current trade day. Prospective mitigation beyond the trade day is reserved for mitigation that cannot be performed before the market is closed, such as mitigation for physical withholding.

5.11.2.1 Mitigation Thresholds

In considering explicit bid thresholds for the California market, the ISO has tried to balance the desire to mitigate anti-competitive bidding behavior with the risk of incorrectly labeling legitimate changes in bidding behavior as anti-competitive. On the one hand, setting thresholds high enough to allow for some price volatility could help further the development of price responsive demand products. Setting the threshold too low will make it difficult to apply AMP to resources that may justifiably have more volatile bidding patterns (e.g., hydro resources whose bid patterns may vary significantly depending on water conditions). Finally, if the AMP thresholds are too restrictive, new generation may choose to locate outside of California.

On the other hand, the ISO does not feel the thresholds developed by the NY ISO are appropriate for the California market. The NY ISO's fairly generous bid and market impact thresholds may be appropriate for markets that are workably competitive most of the time, but the ISO feels these thresholds are too large to provide effective mitigation in the California market, which tends to be significantly less workably competitive.

In balancing these concerns, the ISO proposes the following bid screen and market impact mitigation parameters and thresholds:

ISO Automatic Mitigation Procedures (AMP) Specifications:

AMP Reference Levels

Based on historical bids for all resources.

AMP Thresholds:

Bid threshold above Reference Level = Min (100%, $50/MWh) increase from Reference Level

Price Impact threshold = Min (100% increase, $50/MWh increase)

AMP Applicability:

All resources bidding into the markets to which AMP is applied (including imports), except in hours for which the ISO's day ahead load forecast is greater than 40,000 MW.

An important clarification on the ISO's proposed AMP specifications is that to the extent multiple resources have submitted bids that exceed the respective bid thresholds, they will be mitigated simultaneously to see if they have a material impact on market clearing prices.

As stated earlier, since the ISO will not have a Day-ahead and Hour-ahead energy market in place on October 1, 2002, the ISO is proposing to apply AMP only to the ISO's Real-time Energy Market. Applying an AMP within the Real-time market time frame is problematic, however, because it is simply not feasible to conduct an AMP prior to each 10-minute interval.

Instead, the ISO is proposing to run the AMP in a two-stage process. The first run of AMP will occur during the Day-ahead Residual Unit Commitment (RUC) process, which is in effect a day ahead procurement of resources the ISO expects to need to provide real time imbalance energy. During this stage, if energy bids submitted from AMP resources being considered for RUC exceed their bid thresholds, the ISO will mitigate the bids to see if they have a material impact on projected real-time market prices. Real-time prices will be projected based on the ISO's forecast of real-time imbalance demands. If the bids are found to have had a material impact on market clearing prices, the ISO will use the mitigated bids in deciding which additional units to commit for the next operating day. Since the real time prices computed in RUC are advisory, the impact of AMP in RUC is essentially to ensure the ISO does not purchase highly priced imports just because internal resources have submitted high energy bids that may be subject to mitigation in real-time. However, once the ISO has made the commitment decisions in RUC (including commitment to the tie purchases), it will replace the mitigated bids with the original bids in order to conduct a final market impact assessment closer to real-time, as part of the second stage of AMP.

The ISO will run the second stage of AMP 45-minutes prior to the start of the operating hour after all supplemental energy bids are received. During this process, if energy bids submitted from AMP resources being considered for real-time dispatch exceed their bid thresholds, the ISO will mitigate the bids and test to see if they have a material impact on projected real-time market prices. If bids fail the bid-threshold screen and have a material impact on forecasted real-time energy prices, they would be mitigated. Again, if there are multiple bids from multiple resources that violate the bid threshold, they will be mitigated simultaneously to test for market impact.

The ISO intends to extend AMP to the Day-ahead and Hour-ahead energy markets once those markets are implemented. The application of AMP to these markets should be easier to implement than a Real-time market AMP, since there will be more time in the forward markets to run additional procedures. As the ISO gains experience with the bid screen and mitigation procedures and if the overall competitiveness of the ISO markets improves, the ISO will consider raising the bid and price impact threshold levels. As noted earlier, the AMP will not be applied if the ISO's day-ahead load forecast exceeds 40,000 MW.

5.11.2.2 Reference Levels

a) For purposes of establishing reference levels, bid segments will be defined as follows:

(1) the capacity of each generation resource shall be divided into 10 equal Energy bid segments between its minimum (Pmin) and maximum (Pmax) operating point.

(2) for Energy bids submitted over the intertie Scheduling Points (import bids), 10 bid segments shall be established for each Scheduling Coordinator at each Scheduling Point based on historical volumes over the preceding 12 months.

b) A reference level for each bid segment will be calculated for peak and off-peak periods on the basis of the following methods, listed in the order of preference subject to the existence of sufficient data, where sufficient data means at least one data point per time period (peak or off-peak) for the bid segment:

(1) The lower of the mean or the median of a resource's accepted bids in competitive periods over the previous 90 days for peak and off-peak periods, adjusted for changes in fuel prices;

(2) If the resource is a gas-fired unit, the unit's default energy bid (based on the incremental heat rate submitted to the ISO, adjusted for gas prices, and the variable O&M cost on file with the ISO, or the default O&M cost of $6/MWh).

(3) For non gas-fired units, a level determined in consultation with the Market Participant submitting the bid or bids at issue, provided such consultation has occurred prior to the occurrence of the conduct being examined by the ISO, and provided the Market Participant has provided data on a unit's operating costs (opportunity cost for energy limited resources) in accordance with specifications provided by the ISO.

(4) The mean of the MCP for the units' relevant location (zone or node commensurate with the pricing granularity in effect) during the lowest-priced 25 percent of the hours that the unit was dispatched or scheduled over the previous 90 days for peak and off-peak periods, adjusted for changes in fuel prices; or

(5) If sufficient data do not exist to calculate a reference level on the basis of the first, second, or fourth methods and the third method is not applicable or an attempt to determine a reference level in consultation with a Market Participant has not been successful, the ISO shall determine a reference level on the basis of:

i) the ISO's estimated costs of an Electric Facility, taking into account available operating costs data, appropriate input from the Market Participant, and the best information available to the ISO; or

ii) an appropriate average of competitive bids of one or more similar Electric Facilities.

c) The reference levels ($/MWh bid price) for the different bid segments of each resource (or import bid curve of a Scheduling Coordinator at a Scheduling Point) will be made monotonically non-decreasing by the ISO by proceeding from the lowest MW bid segment moving forward. For each bid segment the reference level of each bid segment shall be the higher of the reference level of the preceding bid segment or the reference level determined according to paragraph (b) above.

5.11.3 Alternatives Considered

An alternative considered for determining the Reference Levels was to use cost-based proxy bids for thermal generators, since investigation of the real-time market revealed that even after the implementation of the June 19 Order the real-time market is not competitive during many hours and successful bids in such a market are not a good proxy for competitive reference bid prices. This alternative was rejected, however, because it would lead to differential treatment of bidders for whom there are no cost-based proxy bids (i.e., hydro, imports, etc.).

Several alternatives were considered for the level of the AMP thresholds, including the following:

Bid above Reference Level = Min (200% increase from proxy, $100/MWh)
Price Impact = $100/MWh

This alternative was not recommended because the threshold values were deemed to be too large to provide effective market power mitigation.

The ISO considered whether or not this mitigation provision should apply to import bids.

Reference levels can be established for imports based on the lower of the mean or the median of an importer's accepted bids over the previous 90 days for similar hours or load levels (similar to the way NYISO established reference levels for resources potentially subject to AMP, and as stated above). Because there are no mitigation provisions to force imports to offer energy into the ISO's energy markets (except when an import is serving as ACAP in the future), as there is with an ACAP or must-offer resource within the ISO control area, the ISO was concerned that an attempt to mitigate economic withholding may simply cause importers to physically withhold from the ISO market. Ultimately the ISO decided to subject all bidders to AMP because the existence of different mitigation rules for different parties invites gaming. In particular, exempting imports from AMP would create an incentive for internal resources to launder their MW and try to sell into the ISO markets as importers.

5.11.4 Comparison with Other ISOs

The only other ISO that has this type of market power mitigation tool is the NY ISO. As discussed above, economic thresholds for energy bids in the NY ISO are set with respect to a resource specific reference level, which is based on the resource's historical competitive bids during similar hours and load levels and adjusted for fuel prices. The bid threshold used by the NY ISO is an increase of 300% from the reference level or $100/MWh, whichever is lower.

Similarly, the NY ISO also uses a fairly generous threshold to determine whether the bids had a "material price effect." For example, the energy market impact threshold used by the NY ISO is whether the bidding behavior resulted in an increase of 200% or $100/MWh, whichever is lower, in the hourly day-ahead or real-time energy Location Based Marginal Price (LBMP) at any location.

The CAISO does not feel the thresholds developed by the NY ISO are appropriate for the California market. The NY ISO's fairly generous bid and market impact thresholds may be appropriate for markets that are workably competitive most of the time, but the ISO feels these thresholds are too large to provide effective mitigation in the California market, which tends to be significantly less workably competitive.

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FERC RULING ON MD02 FILING

The following text, taken verbatim from the June 17, 2002 FERC Ruling [7], is provided as background for defining the structure and issues of surrounding AMP as an element of market design. Most text is easily identifiable from section and paragraph numbers. Some parts have the text *[snip]* added to remind the reader that a large section of text has been skipped. Please refer to the original reference for those portions.

The CAISO Proposal

15. The CAISO states that it recognizes that the current congestion management system is "severely flawed" and that MD02 is intended to provide for more stable operations through the promotion of day-ahead scheduling, commitment and contracting. Furthermore, the CAISO intends that its proposals will increase operational and price transparency through accurate modeling of the transmission system to reveal true and accurate price differences on the system. The May 1 Filing has the following principal elements:

(A) Monitoring and mitigating market power and prices through short-term and long-term measures. Although these are part of the California market design package, the current and some of the Proposed price mitigation measures apply to the entire Western Interconnection[10]. In the short-term, the CAISO proposes to "narrow" the current must-offer requirement in accordance with its residual day-ahead unit commitment process proposal. In addition, the CAISO proposes the use of a 12-month competitiveness index that will attempt to measure the competitiveness of its markets over time against benchmark average market prices. In this proposal, if average market prices exceed the benchmark average prices by more than $5/MWh, the Commission's pre-September 30, 2002 West-wide mitigation measures would be reinstated and bids in the CAISO's markets would be limited in accordance with cost-based proxy bid mitigation measures in all hours, for a period of six months, or until the market is found to be competitive or more permanent solutions can be developed. The CAISO also proposes that, if the Commission decides against extending the existing mitigation measures beyond September 30,2002, certain market power mitigation measures should be implemented on October 1,2002, rather than for the long-term. Specifically, the CAISO proposes that market power should be mitigated through a damage control bid cap (bid cap)[11] and "automatic mitigation procedures." (AMP). Specifically,

[10] The mitigation measures apply to spot market transactions in the U.S. portion of the Western Interconnection.

[11] Although the CAISO describes its bid cap for "damage control" purposes, we believe the bid cap is more appropriately viewed as a safety-net bid cap mechanism. We will use the term "bid cap" in this order to refer to this element.

the CAISO proposes a bid cap with a floor[12] of $108/MWh that can increase with the price of natural gas and over time as additional elements of MD02 are phased in and capacity conditions improve. The CAISO's AMP proposal would apply to bids that substantially exceed historical levels and threaten to materially impact market clearing prices. The CAISO proposes thresholds to trigger AMP when a given resource's bid is the lower of 100 percent or $50/MWh above historically accepted bid levels and would also increase real-time market clearing prices by the lower of 100 percent or $50/MWh. This proposed measure would apply to all bids, including hydroelectric resources and imports, but would not apply during hours in which the CAISO has a day-ahead demand forecast exceeding 40,000 MW, nor would the accepted bids during these hours count toward a resource's historical bid average for mitigation purposes.

(B) Local market power mitigation of suppliers' bids in hour-ahead and real-time spot markets when resources must be taken out of economic merit order to serve local reliability needs. The CAISO states that local market power can occur in the decremental bid market when it must dispatch generators' resources out of merit order for local reliability purposes. The CAISO proposes that unit-specific bid caps be used to mitigate this local market power.

[Snip]

17. In addition to the modified must-offer, bid cap, AMP and local market power mitigation measures, the phase one market design elements that the CAISO proposes to implement on October 1,2002 include the following: the residual day-ahead unit commitment process; real-time economic dispatch; use of a single energy bid curve; penalties on generators for failure to comply with dispatch instructions; a rolling 12-month competitive index with pre-authorized mitigation; and a cap on decremental bids.

[Snip]

39. EPSA states that the CAISO's proposal should not include the $108/MWh price cap noting that the Commission should avoid taking steps to extend the existing price controls in order to address problems that no longer exist. Williams states that a bid cap is entirely unnecessary, but that if the Commission finds that one is necessary, a cap of $108/MWh is insufficient to clear a constrained market. IEP states that the CAISO has not justified the concept of the bid cap in conjunction with the must-offer requirement, local market power mitigation, and the AMP. Even if the concept is sound, IEP states that it is not appropriate to set the cap at $108/MWh.

[Snip]

[12] Floor refers to the CAISO's proposal that the cap increases with changing fuel prices, but can never fall below $108.

B. California Mitigation

1. Automatic Mitigation Procedures

52. The CAISO proposes to apply automatic mitigation procedures (AMP) in both day-ahead and real-time energy markets. However, because it does not currently operate day-ahead energy markets (AMP will apply to the CAISO's Day-Ahead and Hour-Ahead markets once they are developed), the CAISO is proposing to apply AMP starting October 1, 2002, only to its real-time market. The CAISO currently operates its energy market on a 10-minute basis. According to the CAISO, because it is simply not feasible to conduct AMP prior to each 10-minute interval, the CAISO proposes to run AMP as part of its forward (ahead of real-time) scheduling process.

53. Thus, beginning in October 2002, the CAISO proposes to run its AMP process in two stages. The first run of AMP would occur during the CAISO's proposed residual unit commitment process, which it claims is the equivalent of a day-ahead procurement by the CAISO of resources needed to provide real-time imbalance energy. The CAISO proposes to run a second stage of AMP 45 minutes prior to the start of the operating hour, which will occur after all supplemental energy bids are received for that hour.

54. The CAISO claims that its AMP proposal is modeled after one used by the New York Independent System Operator, Inc. (NYISO), but with lower thresholds to reflect the CAISO's claim that the California electricity market is not as workably competitive as NYISO markets. Similar to NYISO, the CAISO's AMP proposal uses two screens to determine whether to apply AMP: one for conduct and one for market impact.[43] The first screen (conduct screen) evaluates a bid for market conduct that is inconsistent with workable competition. The second screen (impact screen) evaluates bids to determine whether they have a substantial impact on market prices. If both of these conditions are met, prospective mitigation to a unit specific reference price is imposed automatically. Specifically, when a bid exceeds the reference price by the lesser of 100 percent or $50/MWh <u>and</u> acceptance of the bid would raise the market price by the lesser of 100 percent or $50/MWh, AMP is triggered. The CAISO further proposes to apply AMP to both in-state resources and imports, including hydro.[44] In addition, according to the CAISO proposal, AMP would not be used in periods when the CAISO day-ahead forecast load is over 40,000 MW.

55. In addition to checking individual bids for an increase above their respective reference prices, the CAISO proposes to aggregate those bids that violate the conduct screen to test for an impact on the market clearing price. If the market clearing price would be changed (increased) by these bids, AMP is triggered. Once AMP is triggered, the affected bids (i.e., those exceeding both the conduct and impact screens) are assigned their respective reference price as a default bid

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[43] The NYISO employs an additional price screen to determine whether to apply AMP to bids. Under that screen, AMP does not apply when unmitigated energy prices are less than $150/MWh throughout NYISO. NYISO implemented this screen after it determined that it was unlikely that the thresholds for mitigation would be exceeded if prices were below $150. The CAISO does not propose to use a similar price screen.

[44] The CAISO, however, also proposes that import bids subject to mitigation under AMP cannot set the market clearing price.

for purposes of determining the market clearing price for the market interval. Those bids are then paid the market clearing price for the market interval, with the exception of imports into the CAISO control area. For imports that are mitigated under AMP, the CAISO proposes to pay those bids the higher of their default bid or relevant market clearing price (because imports are proposed to be ineligible to set the market clearing price).

56. Unlike the NYISO, however, the CAISO does not propose any exemptions from applicability of AMP for: (1) small portfolios (NYISO exempts units with capacity ratings of 50 MW and below); (2) minimum price bids (NYISO exempts bids below $25/MWh); new generation (NYISO uses more liberal reference prices for three years for new resources); and hydroelectric resources and imports (NYISO exempts bids from these resource types).

57. The CAISO proposes to establish the reference price for each in-state generating resource based on its historical bids, or an estimate of its costs. The CAISO has proposed a set of methods with which to calculate reference prices. According to the MD02 proposal, the reference price for each resource will be set using data, subject to availability, in the following specified order:

A. the lower of mean or median of a resource's accepted bids in similar periods during previous 90 days, adjusted for changes in fuel prices (go-day bid prices);

B. for gas-fried units with no significant energy limitations, a default energy bid based on its incremental heat rate, adjusted for gas prices and an O&M adder (default energy bid for gas-fired unit);

C. for non gas-fired units (which would include hydroelectric resources) and gas-fired units with significant energy limitations, a negotiated rate using opportunity cost data supplied by the market participant (opportunity cost negotiated rate for energy limited resources);

D. the mean of the market clearing prices for the unit's relevant location during the lowest-priced 25 percent of the hours the unit was dispatched or scheduled during the previous 90 days for peak and off-peak periods, adjusted for changes in fuel prices (mean of lowest 25 percent hours' clearing prices);

E. the CAISO's estimated cost of a facility based on best available information (CAISO estimate of cost);

F. and the average of competitive bids from similar units (similar competitive bids).

These methods generally reflect those used by the NYISO, but in a slightly different order.

58. A tabular comparison of NYISO AMP and the CAISO AMP proposal is shown below.

Design Element	NYISO AMP	CAISO proposed AMP
Conduct threshold	300% or $100 increase over reference price	100% or $50 increase over reference price
Impact threshold	200% or $100 increase in MCP	100% or $50 increase in MCP
Minimum Price Screen	$150	none
Applicability	- hydro and imports excluded - regulation and operating reserves are excluded - less than 50 MW excluded - more liberal reference price for first three years of a unit's operation - bids below $25 are not mitigated	- hydro and imports included - no provision - no exclusion for small portfolios - no exemption for new generation - no minimum price offer exemption - not applicable when load forecast exceeds 40,000 MW

a. Comments

59. Some intervenors argue that a workable AMP must have a properly designed bid screen that should be more market-oriented than the CAISO proposal, using bid histories or market clearing prices, with marginal cost proxies as a last resort.[45] If a cost-based bid screen is used, Reliant argues that the cost factors must be based on a more complete and realistic representation of costs so that disincentives for construction of new generation are removed. Dynegy and IEP claim that the CAISO AMP is applied too broadly, without a prerequisite that significant congestion exists.

60. Mirant contends that the Commission should require the CAISO to implement the same standards and thresholds used by the NYISO. Dynegy maintains that the CAISO's methodology for setting a unit's reference price should follow the same order of preference used by the NYISO. California Inter-Agency Group and San Francisco protest the CAISO's use of a supplier's historical bids to establish the reference price, arguing that such an approach can be gamed if suppliers act to artificially inflate the reference price. California State Water Project argues that the CAISO provides only a fleeting description of how threshold price levels would be developed for hydroelectric generation and no discussion of how AMP would apply to loads.

61. California Inter-Agency Group protests the CAISO's proposal to suspend the AMP at high load levels, contending that the exercise of market power is the greatest when load is high.

[45] See e.g., Reliant, Dynegy.

62. San Francisco maintains that, if AMP is adopted as proposed, its effectiveness should be reexamined as experience reveals whether the reference levels and bid thresholds that trigger mitigation are effective and appropriate. Williams maintains that the AMP must be designed on a regional basis, recognizing values and opportunity costs across the entire WECC region, especially during shortage conditions.

63. The Market Surveillance Committee believes that the local market power of some suppliers was among the greatest structural problems in the California market.[46] The existence of transmission constraints within the CAISO system remains a structural problem that continues to give suppliers local market power. The Commission has adopted and approved measures to mitigate this problem for all East Coast ISOs. The Market Surveillance Committee believes it is important for California to have comparable measures. The Market Surveillance Committee strongly agrees with the CAISO that an ACAP market is not practical to implement over the short-term. Though the Committee believes that ACAP may best address market power, they note that in the short run, AMP is the best solution. According to the Market Surveillance Committee, even though the CAISO has a number of generating units under Reliability-Must-Run (RMR) contracts that it can call to mitigate local market power, system conditions often occur when generating units other than RMR units are able to exercise local market power. Consequently, the Market Surveillance Committee strongly supports the implementation of an automatic mitigation procedure on all generating units that possess local market power according to a clearly articulated criterion.

b. Commission Ruling

64. We note that a fundamental purpose of AMP is to limit the exercise of market power, not to suppress prices during scarcity conditions. AMP should not limit prices from rising to the level needed to clear the market, instead it should simply limit the ability of suppliers to artificially raise prices when market conditions may create a temporary ability to do so. We have previously found that AMP can be effectively implemented as a market power mitigation tool without interfering with the efficient and reliable operation of the grid.[47]

65. The CAISO proposal to run AMP in two stages beginning October 1,2002 is acceptable, with certain modifications. As discussed later in this order, we reject the CAISO's proposal to implement an interim residual unit commitment process as unnecessary due to the extension of the existing must-offer obligation and the fact that it will be developing a resource adequacy condition, whether it is ACAP or some other method. Rejection of the interim residual unit commitment proposal, however, should not affect the CAISO's ability to run the first stage of AMP because the CAISO indicates that it has already developed software to support the waiver process approved by the Commission to complement the must-offer obligation. In fact, the CAISO admits that the process of granting or denying waivers and for recalling units that were

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[46] The Market Surveillance Committee includes asymmetric treatment of final consumers and producers of electricity, and the lack of sufficient forward contracting by load-serving entities in its list of the three main structural problems in the California markets (Market Surveillance Committee at 2).

[47] 47See e.g., New York Independent System Operator, Inc., & & 99 FERC 1 6 1,246 (2002), New York Independent System Operator, Inc., 95 FERC T[6 1,47 1 (200 1).

previously granted a waiver is basically a residual commitment process.[48] The CAISO further indicates that software being used to do this makes use of Transmission Constrained Unit Commitment (TCUC) software. In addition, to implement its residual unit commitment, the CAISO was proposing to extend and modify the use of the TCUC software. Consequently, we direct the CAISO to apply the AMP procedures at the time it runs the TCUC for granting waivers of the must-offer obligation.

66. The combination of the AMP with a \$250/MWh bid cap gives the CAISO a comprehensive mitigation plan to guard against economic withholding. However, we agree with certain interveners that applying the screens, at the levels proposed by the CAISO, may result in mitigating bids unnecessarily. Thus, we will require certain modifications to the CAISO's proposed AMP process.

67. We approve the use of conduct and market impact screens to assess whether bids will be subject to AMP. In addition, as discussed below, we will require the CAISO to use a third test, a price screen, to determine whether a bid will be mitigated under AMP. We require the CAISO to apply such screens using the following thresholds:

A. For the conduct screen, the threshold will be whether the individual bid would result in a 200 percent or a \$100/MWh increase, whichever is less, above the reference price established for the unit;

B. For the impact screen, the threshold will be whether the aggregated bids that fail the price screen would result in a 200 percent or a \$50/MWh increase, whichever is less, in the market clearing price;

C. For the price screen, if the market clearing price for all zones is \$91.87/MWh or below, AMP will not be applied.

68. According to its May 1 Filing, the CAISO considered thresholds ranging from 100 percent/\$50 to NYISO's 300 percent/\$100 for conduct and 100 percent/\$50 and 200 percent/\$100 for impact. We agree with the CAISO that thresholds must strike a balance between being overly restrictive and overly generous. As the CAISO correctly states, "setting the threshold too low will make it difficult to apply AMP to resources that may justifiably have more volatile bidding patterns (e.g., hydroelectric resources whose bid patterns may vary significantly depending on water conditions) … [and] if the AMP thresholds are too restrictive, new generation may choose to locate outside of California."[49] Accordingly, the Commission finds it appropriate to adjust the levels of the thresholds as described above.

69. We agree with San Francisco, "AMP's effectiveness should be re-examined as experience reveals whether the reference levels and bid thresholds that trigger mitigation are effective and appropriate." The Commission agrees and will review the levels of these thresholds as

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[48] See May 1 Filing, Attachment A at 109.

[49] See May 1 Filing at 138.

appropriate. We direct the CAISO to file quarterly reports detailing the impacts of its AMP measures.

70. We also believe the calculation process for determining a reference price (the price at which a bid will be mitigated if AMP is applied) affords too much discretion to the CAISO.[50] We share interveners' concerns regarding the calculation of reference prices, and believe that those concerns are best addressed by requiring an independent entity to calculate reference prices. Accordingly, we will require the CAISO to issue an RFP within 30 days (using the MISO RFP for hiring its independent market monitor) to retain the services of a qualified independent organization to perform the task of determining reference prices for each generator in California and each Scheduling Coordinator providing energy at each scheduling point across an inter-tie."[51] Selection of the entity must be completed and its identity submitted to the Commission by September 15, 2002. Application of AMP by the CAISO will not be permitted until such entity is in place.

71. The Commission agrees with the CAISO's proposal to include hydroelectric resources and imports as bidders subject to AMP. Unlike NYISO, hydroelectric resources and imports constitute a significant portion of California energy supply Without AMP applied to imports, for example, concerns with megawatt laundering arise.

72. As noted above, we direct the CAISO to adopt a price screen as an element of AMP. We will direct the CAISO to establish the initial level of the price screen at $91.87/MWh. Under the price screen, if the markets clear below this level in all three zones in California, no AMP will be applied. The establishment of a bid screen also should provide certainty to potential suppliers.

73. The Commission believes it appropriate to exempt small portfolios from AMP once the full network model is in effect in late 2003. Additionally, bids below $25/MWh should be exempt from AMP because small dollar increases at this level translate into large percentages, but the impact on the market is generally insignificant.

74. As a final matter, the CAISO proposes that AMP would not be applied when its day-ahead forecasted load exceeds 40,000 MW. In opposition, the California Inter-Agency Group argues that the CAISO has failed to provide any explanation why it believes mitigation is not needed when load is high and the potential for exercise of market power is the greatest. We agree with the California Inter-Agency Group that protection from market power should apply during times of high demand, and note that any potential for market power that exists when demand is below 40,000 MW could well exist at levels above 40,000 MW. While it is important to allow the price signals scarcity creates, we also believe it is important to protect customers from market power. The AMP adopted here accomplishes this.

75. An AMP with appropriate thresholds is designed to allow prices to rise during times of scarcity, thereby allowing for appropriate price signals and incentives for supply to enter the

[50] See the concurrently issued Order Concerning Governance of the California Independent System Operator Corporation, Mirant Delta, LLC, and Mirant Potrero, LLC, & et al., Docket No. ELOl-35-000 et al.

[51] We direct the CAISO to use the MISO RFP as a template for this task.

market. We believe that the AMP mechanism we approve in this order provides important protection against the exercise of market power and can properly differentiate between the exercise of such market power and true scarcity prices when demand is high. As such, the CAISO's concerns that resources will not be made available to meet high levels of demand will be alleviated by allowing the market to accurately reflect scarcity without triggering mitigation. We will therefore reject CAISO's proposal not to apply AMP when load forecasts exceed 40,000 MW. We also will direct that prices at all load levels shall be included in the reference level calculation, since excluding such prices would extinguish the signal that additional supply is needed.

76. We direct the CAISO to file, within 30 days of the date of this order, tariff language implementing the AMP as discussed above.

2. Local Market Power Mitigation[52]

77. In light of the increasing amounts of intra-zonal congestion, the CAISO proposes to implement, immediately upon Commission approval, a local market power mitigation measure.[53] Under the local market power mitigation proposal, when the CAISO must dispatch a unit out of merit order to alleviate intra-zonal congestion, it would mitigate those bids by capping the bid of a generating unit at its short-run variable cost. The CAISO cites the example of PJM's authority to cap the cost of must-run units in the real-time market and also notes that other Eastern ISOs, such as NYISO and ISO New England, have Commission-approved locational market power mitigation programs in place.[54]

78. According to the MD02 proposal, if intra-zonal congestion cannot be alleviated by "reliability must-run" procedures and the CAISO must dispatch a unit out of merit order, that unit's bid will be mitigated to a proxy price as an estimate of its short-run variable costs. The unit will be dispatched pursuant to the adjusted bid in order to alleviate the intra-zonal congestion. The Scheduling Coordinator for that generating unit will then be paid the higher of its proxy price or the applicable market clearing price for incremental dispatch, or charged the lower of its proxy price or the applicable market clearing price for decremental dispatch. The CAISO will calculate the proxy price daily for each gas-fired generating unit a generator subject to the must-offer requirement owns or controls by applying the filed heat rates for those generating units to a daily proxy figure for natural gas costs with an additional $6/MWh allowed for operations and maintenance expenses.

79. The CAISO also proposes to modify the local market power mitigation mechanism effective October 1, 2002 by replacing the proxy price with a default energy bid price. The CAISO will determine default energy bids using cost data that a generating unit's Scheduling Coordinator

[52] In this order, we use the term, "local market power mitigation," instead of the CAISO's term, "locational market power mitigation," because the former term more accurately describes the proposal.

[53] This measure would supplement the CAISO's existing reliability must-run (RMR) procedures under which it pays certain designated units needed to run in local areas a negotiated cost-based price for their output.

[54] See May 1 Filing at 26-27.

submits. From that data, the CAISO will construct a bid curve for the unit representing its incremental variable cost over the range of its sustainable output.

a. Comments

80. TANC supports the CAISO's proposed intra-zonal congestion management plan as an interim measure. California State Water Project also supports the local market power mitigation plan, but suggests using the NYISO "in-city" AMP procedures. The Market Surveillance Committee proposes that the CAISO use its AMP for local market power mitigation. California Inter-Agency Group supports the CAISO's proposal that when intra-zonal congestion occurs, the CAISO will limit schedules in the day-ahead market and cap bids at marginal costs, but it disagrees with the CAISO's proposed method of determining whether a unit has local market power.

81. San Francisco supports the CAISO proposal, although it believes that the proxy price is overly-generous. It also maintains that generators' cost data should be submitted publicly, so that all interested parties may determine whether the mitigated price paid to generators is just and reasonable.

82. Metropolitan states that, even though it recognizes the need to prevent the exercise of market power, the CAISO's proposal appears to have several significant errors or ambiguities. Metropolitan also contends that congestion management should be accomplished using thermal generating, and not hydroelectric units.

83. Reliant states that the price mitigation proposals artificially limit prices in so many ways that they create a de facto cost-based regime (effectively perpetuating the current mitigation measures). Dynegy states that the CAISO is apparently trying to create an incremental cost-based market outcome without guaranteeing the opportunity for fixed cost recovery and extremely limited potential for return on investment.

84. Duke supports the principle of limiting prices for generators dispatched to relieve intra-zonal congestion in circumstances where localized market power has been demonstrated, but it states that those caps should reflect market-based, not cost-based, proxy prices.

85. Mirant asks the Commission to reject the CAISO's duplicative local reliability mitigation measures or, in the alternative, modify the proposal to the following: (a) limit mitigation to instances where competition may be ineffective; (b) provide appropriate price signals; and (c) reflect the value of reliability services.

86. Calpine states that the CAISO proposal has three fundamental flaws: (1) it penalizes new generation owners that have paid the full costs of system upgrades that had been identified by the transmission owners, in coordination with the CAISO, as being needed to accept power from the new facility on the grid; (2) it uses a "cost-based" proxy bid to mitigate the potential for the exercise of market power in situations where such a potential may not exist at all because of the existence of multiple competitors to provide the service; and (3) the "cost-based" proxy bid the CAISO proposes does not compensate generators for actual costs they may incur when they decrease generation and, therefore, must be modified.

87. Redding states that the CAISO's market power mitigation proposals inappropriately treat constrained and unconstrained markets with a single approach. Redding maintains that market power mitigation measures are not necessary in markets where there are multiple buyers and sellers.

b. Commission Ruling

88. The Commission recognizes that transmission constraints or concentration of generation ownership may cause situations to arise in which the number of bids in certain areas of the grid or across transmission pathways is not sufficient to consider them competitive. Load pockets, generation pockets or local reliability problems resulting from such a situation may place a generating unit in a position to exercise market power.

89. The CAISO's current market rules rely on RMR units to relieve transmission congestion.[55] The CAISO states that although it recognizes the value of RMR as a tool to address local reliability needs and to resolve intra-zonal congestion, it has been reducing the number of RMR units, and is proposing to phase out existing RMR generation requirements by 2006 as its ACAP is implemented.[56] The CAISO believes that this timetable will provide sufficient time for the development of appropriate local market power mitigation instruments, including new and/or modified RMR contracts.[57]

90. The ultimate solution to this problem in California is the use of AMP in concert with a day-ahead market and the nodal pricing of the CAISO's full network model.[58] However, neither of these elements will be in place on October 1, 2002. It is evident to the Commission that the CAISO's local market power mitigation measure, as proposed, is inappropriate in light of the existence of a three-zone congestion management model. We find that there is a need for an appropriate interim measure in order to provide protection from the possible exercise of local market power during the transition to the full network model.

91. Though RMR resources are inadequate to address all instances where market power could be exercised, we will direct the CAISO to use its existing RMR generation to its full extent for reliability purposes and to alleviate intra-zonal congestion. We note that RMR resources are not subject to AMP and do not set the market clearing price.

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[55] RMR contracts are negotiated agreements between the CAISO and a generator that provide for the recovery of a portion of the generator's fixed costs as well as its variable costs.

[56] See May 1 Filing, Appendix A, at 69-70.

[57] Answer at 124.

[58] For this reason and others, we are directing the CAISO to expedite the implementation of its day-ahead market and, moreover, urge the CAISO to use all deliberate speed to implement its full network model.

92. In situations where RMR resources are not available, and bids must be taken out of merit order for the specific purpose of alleviating intra-zonal congestion, we direct the CAISO to apply its AMP procedures[59], as modified below, to test for the possible exercise of local market power.

93. A bid less than $91.87/MWh that is taken out of merit order will not be subject to any mitigation. If a bid taken out of merit order is greater than $91.87/MWh, it is assumed to have failed the conduct test (the first AMP screen). To test for market impact (the second AMP screen), if an out of merit order bid is $50/MWh greater than the market clearing price or over 200 percent greater than the market clearing price, that bid will be mitigated and the generator will be, paid the higher of its reference price or the market clearing price. An out-of-merit bid (whether mitigated or not) is ineligible to set the market clearing price.

94. We direct the CAISO to file revisions to its AMP proposal to include these provisions to address local market power.

[59] We view local market power mitigation and AMP as companion, if not interchangeable, mitigation measures.